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# Agriculture for Southern Schools

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BY

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*Revised Edition*

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1923

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# PREFACE

## To the Revised Edition

In sending forth this revised edition the author is encouraged by the favorable reception accorded to earlier editions of *Agriculture for Southern Schools*. Its use as the officially adopted textbook for the grammar grades of a number of the Southern States has shown the need for an elementary book focused wholly on the agriculture of the South. Its wide adoption in the public schools of this region has afforded opportunity for the writer to make use of many helpful suggestions from those who have taught and studied this book.

The author has treasured these constructive criticisms as well as the kind commendations and has endeavored to weave into the revised edition the results of experience thus accumulated throughout the fourteen years since this book was first published. The book has been rewritten to conform to the results of the most recent research in agricultural science and the most approved methods in education.

Among the concrete improvements over earlier editions are the up-to-date character of the subject matter; the more simple, systematic, and pedagogical character of the practical exercises at the end of each chapter; the use of a large number of new and superior illustrations; changes in the order of topics and provision for the teacher to have even greater freedom to vary the sequence of chapters according to local requirements; and the still further simplification of subject matter and method.

Arithmetical problems in compounding rations and fertilizer formulas have been removed from the text, although

they are still available for ambitious pupils in the Appendix, as well as to teachers in the Teachers' Handbook.

As typical examples of topics of the most recent interest here discussed are the coöperative marketing of farm products, vitamines in the food of mankind and of farm animals and, among the farmers' enemies, the recently introduced Mexican bean beetle. The spread of the Mexican cotton-boll weevil throughout practically all of the Cotton Belt has necessitated profound changes in Southern agriculture. What the boll weevil has done for cotton culture the new Mexican invader, the bean beetle, threatens to accomplish not only for the garden beans but also for the cowpea and certain other legumes, and consequently for current systems of farming and soil improvement, builded largely on the use of these susceptible plants. These pests are not only discussed, but throughout the book recommendations on farming practice are made to help reduce the harm of these and other pests widely prevalent in the South.

For ambitious teachers to make the most of the subject of agriculture, the author has carefully prepared a Teachers' Handbook, in which are suggested for each chapter the appropriate season, desirable specimens, or other illustrative material, suitable additional exercises for practice or for home projects, references to appropriate government publications, and means of correlating the lessons in agriculture with those in other subjects. These helps are published as a separate pamphlet, but the writer has been at special pains to make the text of *Agriculture for Southern Schools* complete in itself for the teacher as well as for the pupil.

J. F. DUGGAR

Auburn, Alabama

## SUGGESTIONS TO THE TEACHER

By Frances C. and J. F. Duggar

(1) The teaching of agriculture may be more flexible than that of many subjects, especially in regard to the order in which the topics may be studied. The chapters in this book have been arranged carefully, but no one arrangement would suit every condition, for schools open in various months. If the order in the textbook throws any lesson out of season, turn to that lesson sooner or temporarily omit and study it later. Study the field crops when they are growing or maturing in the field, the parts of a flower when they are in bloom, and so on. In midwinter when specimens are scarce study chapters that do not require plants in active growth, as those on trees, pruning, and live stock.

(2) Divide the longer chapters into two or more lessons, if desirable. A chapter is not always a single lesson but a logical division of subject matter.

(3) Inspire the pupils to bring to school all needed specimens. Plan ahead and tell the children in advance what is needed for the following lesson.

(4) Study agriculture first-hand. Arouse interest by trips and excursions to fields and woods.

(5) Let the pupils do more than merely recite on the text. Let them observe and tell their observations. Let them discuss the lesson principles in relation to local agriculture. Let them make drawings and work problems to impress the points of the lesson. Lead them to think and deduce correct conclusions from what they observe.

(6) Correlate agriculture with drawing and arithmetic as suggested above. Correlate agriculture with language work by means of oral and written compositions on agricultural subjects of vital interest to the pupil.

(7) If time permits or if the exercises suggested in the textbook are not sufficient for your needs, use the additional exercises and experiments given in the Teachers' Handbook.

(8) Require a notebook of each pupil, in which are kept records of all experiments, drawings, and as many of the answers as practicable to questions asked in the text.

(9) Be broad in your attitude toward agriculture. Do not claim to know everything about the subject. Make the children understand that no one person can know it all. Guide the children to observe and think and yourself to learn with them. Respect the parents' views on agricultural practices. If you differ with them, give your reasons but do not argue. The child will be quick to see the better way.

(10) Do not require exactly the same practical work from all pupils. Encourage students to carry on the *home projects* suggested in the "Practice Work and Questions" and give extra credit for all good agricultural work done at home and recorded in writing. For example, one boy may raise a calf, another a crop of corn. The boy who raises the calf should give extra attention to feeding problems, the boy who raises corn to fertilizer questions.

(11) Get in touch with your county farm and home demonstration agents, and let the school be the center of such agricultural clubs as most interest the boys and girls.

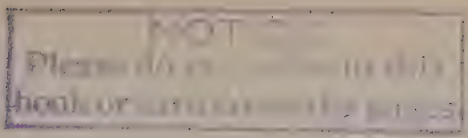
(12) Write well in advance for all the *free* pamphlets suggested in the Teachers' Handbook. These and some Southern farm paper will be invaluable helps to you, to the pupils, and to their parents.

## CONTENTS


| Chapter | | Page |
|---|---|---|
| I | Why Study Agriculture? | 3 |
| II | Germination of Seed | 8 |
| III | Testing Seed | 14 |
| IV | Water and Food from the Soil | 18 |
| V | How Plants Get Food from the Air | 24 |
| VI | The Parts of the Flower | 29 |
| VII | Pollination | 34 |
| VIII | Improvement of Plants | 43 |
| IX | How the Soil Was Formed—Kinds of Soil | 50 |
| X | Moisture in the Soil | 57 |
| XI | Preparation and Cultivation of the Soil | 61 |
| XII | Terracing and Draining | 66 |
| XIII | How the Soil Becomes Poor | 73 |
| XIV | How Leguminous Plants Enrich the Soil | 77 |
| XV | Barnyard Manure | 81 |
| XVI | Commercial Fertilizers | 87 |
| XVII | Getting the Fertilizer to Crop and Soil | 94 |
| XVIII | Lime | 98 |
| XIX | Corn | 103 |
| XX | Selecting or Judging Seed Corn | 111 |
| XXI | Wheat, Oats, Rye, and Barley | 119 |
| XXII | Cotton | 126 |
| XXIII | Sugar Cane | 134 |
| XXIV | Sweet Potatoes | 141 |
| XXV | Peanuts and Watermelons | 145 |
| XXVI | The Inoculation of Leguminous Plants | 152 |
| XXVII | Some Leguminous Plants for Forage and Soil Improvement | 158 |
| XXVIII | Rotation of Crops | 165 |

| Chapter | | Page |
|---|---|---|
| XXIX | The Making of Pastures—Grasses | 170 |
| XXX | Weeds | 174 |
| XXXI | Multiplying Plants without Seeds | 180 |
| XXXII | Growing Tomatoes and Other Vegetables | 185 |
| XXXIII | Growing Flowers | 193 |
| XXXIV | Grafting and Budding Fruit Trees | 200 |
| XXXV | Growing and Pruning Fruit Trees | 204 |
| XXXVI | Trees for Shade and Timber | 212 |
| XXXVII | Causes of Diseases of Plants—Grain Diseases | 218 |
| XXXVIII | Some Diseases of Fruits | 223 |
| XXXIX | Diseases of Tomatoes and Potatoes | 228 |
| XL | Diseases of Cotton | 233 |
| XLI | Insect Life and Growth | 240 |
| XLII | Insects and Health | 245 |
| XLIII | Biting and Sucking Insects—Some Pests of Garden and Orchard | 252 |
| XLIV | Some Insect Enemies of Corn and Cotton | 263 |
| XLV | The Mexican Cotton-boll Weevil | 266 |
| XLVI | Beekeeping | 272 |
| XLVII | Improvement of Live Stock—Breeds of Horses and Sheep | 278 |
| XLVIII | Breeds of Cattle and Hogs | 289 |
| XLIX | Classes and Varieties of Chickens | 300 |
| L | Caring for a Flock of Chickens | 307 |
| LI | How Farm Animals Use Plants for Food | 312 |
| LII | Feeding a Pig | 317 |
| LIII | Feeding the Cow and Her Calf | 324 |
| LIV | The Production and Care of Milk | 329 |
| LV | Making Butter | 334 |
| LVI | Farm Implements and Machinery | 339 |
| LVII | Earth Roads | 347 |
| LVIII | Marketing Farm Products | 350 |
| Appendix | | 357 |
| Index | | 363 |

# AGRICULTURE FOR SOUTHERN SCHOOLS



## CHAPTER I

## WHY STUDY AGRICULTURE?

If we try to observe the plants that grow in the woods or the field or the garden or the orchard, we shall always be making interesting discoveries and gaining new plant friends. There is not only delight in collecting the wild flowers and in observing the trees, but there is also pleasure and profit in learning the nature and habits of our cultivated plants. We shall know better how to prune a peach tree, an apple tree, or a grapevine if we observe whether the fruit is borne on new branches or on those one or two years old. We shall be able to select better seed corn if we learn which shape of ear or of kernel is found in the best varieties. Agriculture deals with such questions as these.

**Agriculture defined.** — Agriculture is the practice of producing useful plants and animals. It is based on physiology, botany, chemistry, and other natural sciences. It is also an art because success in agriculture requires skill and experience and business methods. In agricultural books, papers, and pamphlets is recorded much of the experience of the best farmers. In studying agriculture we shall learn something about flowers, fruits, vegetables, and animals, as well as about crops that grow in the fields.

**Reasons for studying agriculture.**—Agriculture is worthy of our most earnest study. It is the industry that furnishes food for all mankind and upon which many arts and industries are built. Its study teaches us how plants feed, grow, and

multiply; how man may take common plants and greatly increase their productiveness, beauty, or hardiness; how he may raise animals; how a farmer may make his poor soil rich, his scant crops bountiful, and the life of his family full of comfort and happiness. Surely it is worth while to learn how to make the crops larger, the farm animals more useful and profitable; how to make the garden and orchard yield a

FIG. 1. — PET CALVES AND THEIR OWNERS

continuous supply of vegetables and fruits; and how to beautify the grounds around the home and the school.

It is worth while also for all of us to know how to protect plants from disease and how to conquer insect foes. If blights, smuts, and mildews destroy the crops of field, orchard, or garden, knowledge suggests ways of preventing or destroying them. If caterpillars, bugs, weevils, and a

*Courtesy of Georgia State College of Agriculture*

FIG. 2. — GEORGIA CLUB BOYS LEARNING TO JUDGE DAIRY COWS

host of other insect pests strip bare the growing crops and despoil the stored grain, knowledge of their lives and habits is the weapon with which man conquers them. Best of all, the study of agriculture should enable one to find a keener pleasure in observing the ways of plants and animals (Fig. 1),

FIG. 3. — FLORIDA GIRLS RECEIVING FROM THE GOVERNOR PRIZES WON IN CLUB CONTESTS

and thus enrich his entire life, whatever may be his future occupation.

**Rural life becoming more attractive.** — Formerly to live in the country meant a lonely life. Now country people

find it easier to associate with their neighbors, as roads have improved, country schools have become better, and telephones and automobiles have come into more general use. Pupils in every school may now have their agricultural clubs helped by the county farm and home demonstration agents.

In country homes are now found many comforts formerly confined to the cities, such as waterworks, electric lights, daily mail delivery, and telephones. The number of homes that will enjoy modern conveniences will grow with the increase of boys and girls who learn how to make farming more profitable than it has been in the past. Large profits in farming are most useful when they bring increased comfort, better educational and social advantages, and greater protection of health. Even a child may have a part in bringing these things to pass.

### Practice Work and Questions

1. In your notebook write a list of the principal crops of field, orchard, and garden grown by the farmers of your neighborhood.

2. Write a list of the kinds of farm animals or animal products generally sold by local farmers.

3. If the teacher should later arrange an excursion for you to see some of the best breeds of live stock, what farms near by would you prefer to visit?

4. **Home project.** Find out, partly by using the references in the Index of this book, what is meant by "home project."

Have you ever raised a pig or a calf of your own or taken entire care of a flock of chickens or grown an acre of corn or other crop or any vegetables and flowers? Later chapters of this book will tell you something of the best ways of doing such things as these.

## CHAPTER II

## GERMINATION OF SEEDS

We know that the only plant that can grow from an acorn is an oak tree. When we see a watermelon seed we think of the juicy melons that it should produce. Can any member of this class tell by merely looking at a seed whether it will develop into a strong or a weak plant? Can one even be sure that any particular seed will come up if planted? There are ways by which you can determine whether a seed is alive and able to grow or whether it is already dead and unfit for planting.

**Helping by testing seed.** — You boys and girls who study agriculture in school can put your knowledge to good use and can help your parents to produce larger crops by testing the seed intended for planting. In the next chapter you will learn how to make such a test; but first we need to know something about the parts of a seed and how to make seeds germinate, or sprout.

**Main parts of a seed.** — A seed consists of two main portions. One is the part that gradually changes into a tiny plant during the process of germination; this is called the *germ* of the seed. The other portion consists of starch and other stored-up substances; during and just after germination these materials are dissolved by moisture and then serve as food for the young plant that develops from the germ. Wrapped around both of these is a thin tough cover called

the seed coat: this is the bran of corn and the hull of cotton seed.

**Food for the young plant.** — Look at the layers of starch that you will discover when you cut across a grain of corn (Fig. 4). This starch has been placed near at hand to supply the tiny plant with food before its own roots and leaves can obtain it from the soil and air.

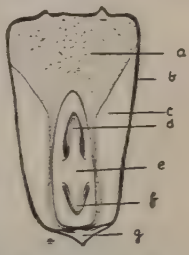



FIG. 4. — A CORN KERNEL

*a*, crown starch; *b*, hull; *c*, horny starch; *d*, shoot of embryo; *e*, germ; *f*, root of embryo; *g*, tip cap.

**Moisture needed to make seed sprout.** — Did anybody in this class ever plant seed when the ground was dry and no rain fell soon afterwards? Did the seed come up? Why not?

**Heat required for germination.** — Oats that were sown in very cold weather have sometimes remained unsprouted for a month. When the sowing was in warmer weather, they came up in about one third of that time. Seeds of distinct plants require very different amounts of heat to make them sprout, or germinate. Seeds of wheat, oats, rye, and barley germinate when the soil is quite cool, and so the farmer sows these crops in the cooler part of the year. Corn grains require more heat than oats but less than the seeds of cotton, cowpeas, or peanuts. A farmer never plants these latter crops until the soil has become somewhat warm.

**Sprouting seeds need air.** — Corn planted in a field that is afterwards overflowed by a creek for several days fails to come up. This is because the water keeps the air away from the seeds. Sometimes the air is kept from the seed planted in stiff clay soils by a hard crust that forms when beating

rains are followed by very dry weather. Many seeds then fail to germinate, and the farmer complains of a "poor stand of plants." The breaking of this crust by harrowing or other form of cultivation admits air and may avoid this difficulty.

**Three conditions for germination.** — We now understand that for a seed to germinate it must have *moisture*, *air*, and *the proper amount of heat*. All three of these must be present at the same time; otherwise the seed will remain inactive or will die.

**The beginning of growth.** — If you soak the seeds of squashes, watermelons, peanuts, beans, cowpeas, or peas, you will be able to distinguish plainly the germ, or growing part, from the surrounding food materials. The germ appears as a very small flattened white bud lying between the fleshy "halves" of such seeds. This bud is really a baby plant, and if you observe its growth from day to day you will find that from its tip develop leaves and from its base the first roots grow (Fig. 5).

*Courtesy of University of W. Va.*

FIG. 5. — SPROUTED CORN, TWELVE DAYS AFTER PLANTING

**Where food is stored for the young plant.** — On examining the soaked seed of beans, cowpeas, watermelons, or

peanuts, you will find that after the outer coat is removed, they easily split into "halves." These thickened parts are packed full of starch and other substances that just after germination will nourish the young plant for a little while. It is fortunate for us that nature has provided these food supplies, or "plant pantries," for they make up a large part of our food. We utilize the stored-up starch of corn and wheat for flour and meal, and also make use of the oil stored up in cotton seed and peanuts.

**How a bean or cotton seed comes up.** — When germination occurs, the bud of the bean, squash, and many other plants is pulled to the surface of the ground in an interesting way. That part of the stem just below the seed leaves rapidly increases in length, humping itself into a loop. Hence the first thing seen above ground is a part of the stem shaped like the center of a wire staple. From one end of this staple tiny roots grow out, while the other end bears the seed leaves, which are still imprisoned in the seed coat underground. However, the stem is steadily pulling this end out of the old seed coat, and by a backing process it soon brings above ground both the fleshy seed leaves and the tiny bud nestling between them. Now the stem lifts its head, straightens its back, and, if the seed coat adheres, pushes it off (Fig. 6).

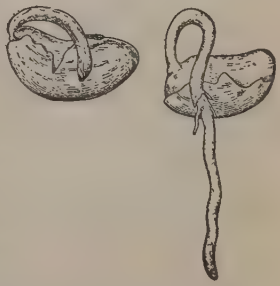


Fig. 6. — The Plant Breaking out of the Seed

So hard is the pull of the stem that little plants sometimes "break their backs" in the effort to come up. Hence farmers are careful in clay soils not to cover deeply the seed of soy-

beans, lest a crust should form above them and the seedlings "break their backs."

**How a garden pea comes up.** — The young stem of the garden, or English, pea after germination also humps its back and pulls its *real* leaves out of the soil backwards. But the garden pea, unlike the beans, keeps its two seed leaves underground (Fig. 7) because the part of its stem that grows rapidly just after sprouting occurs is *above the seed leaves.*

FIG. 7. — GERMINATION OF THE PEA

The seed leaves of all these plants, whether coming above ground like those of beans, cowpeas, squashes, and cotton or remaining in the soil, serve to feed the young plant before its own roots and leaves can support it. At first these seed leaves are thick, but as the food in these "pantries" is given to the growing plant, the seed leaves shrivel and finally disappear. Since these seed leaves have to do a very different work from that performed by the later or true leaves, they naturally look very different.

### PRACTICE WORK AND QUESTIONS

1. Soak a few dozen grains of corn in water so that you may be able better to separate their parts. Then remove the outside seed coat. With a sharp knife cut crosswise through a dry or soaked kernel, with its groove side up. (See Fig. 4.) You will probably be able to see, first, a cream-colored portion or germ next to the groove; second, a layer of soft

white starch; and, third, a harder whitish layer, also made up chiefly of starch.

In your notebook make a drawing, showing how the cut grain appears, and label the germ, the starchy part, and the seed coat.

2. Prove that seeds need moisture in order to germinate by planting some seeds in two tomato cans in the window; keep the soil in one can very dry and in the other barely moist. After one week write in your notebook what has happened.

3. Plant in warm, moist soil, or in a box or can inside a window, seeds of some of the plants mentioned in this chapter. After a few days dig up some of them and compare with the pictures and statements in this chapter.

4. Search in field and garden for seeds of any kinds that have sprouted or for little plants that have recently come up. Bring as many different kinds of these as possible to the class. There the teacher will let you tell your classmates what kinds of seeds or baby plants you have brought, whether each kind brings its seed leaves to the surface or keeps them buried where the seed is planted, and many other interesting facts that the eyes and brain of every bright boy and girl can discover on looking for new facts.

Do you find thick seed leaves on tiny plants of corn or wheat or oats or grass? Do these grasslike plants first show above ground a single straight leaf or a humped stem like the beans and peas and cotton?

## CHAPTER III

## TESTING SEED

Money is often wasted in buying seeds that will not sprout. This is because (1) they may be too old, (2) they may have been gathered when immature, (3) they may have become damp and hot during storage, or (4) they may have been injured by insects or disease.

**Testing seed.** — In some counties the children of the schools regularly test each ear of corn planted by their parents and thus insure more complete stands of plants and larger yields of corn. You can do as much for your neighborhood by testing the planting seed of corn, cotton, and other crops.

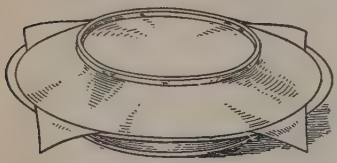


FIG. 8. — A HOMEMADE SEED TESTER

A test of seed is intended chiefly to find out what proportion is able to germinate. Hence this is called a *germination test.* It can be made by using any one of several different kinds of homemade testers described in the exercises in this chapter.

**Taking care of the tester.** — In the last chapter you learned that sprouting seed require moisture, warmth, and air. This is the reason why the cloth or other material next to the seed in any form of tester must be kept moist and

placed in a warm room. The seed are not allowed to be covered with water because this would exclude the necessary air.

**What the count of sprouted seed means.** — Suppose John's notebook shows that he placed 100 seeds in the

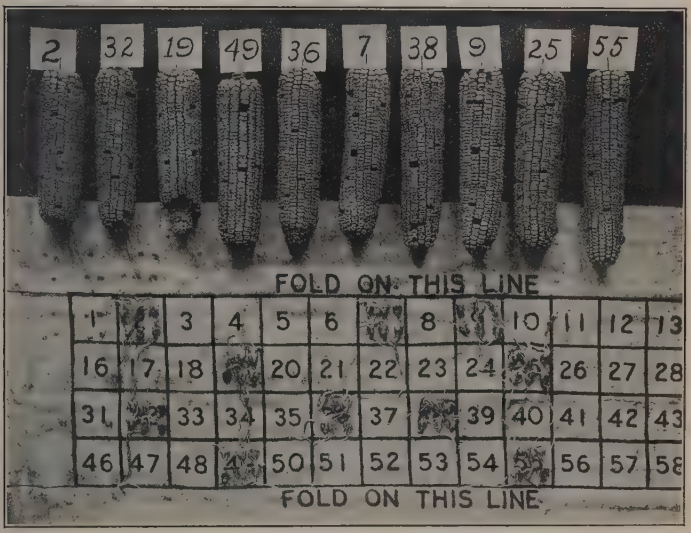


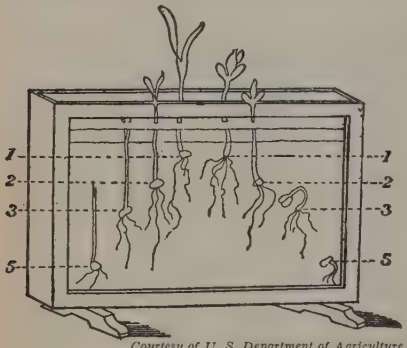

FIG. 9. — A RAG-DOLL TESTER UNROLLED

The numbered squares, sprouted grains, and ears tested are shown.

germinator and that by the eighth day only 80 of these had sprouted; that is, only 80 per cent of the seeds were fit for planting. This shows that John has a poor sample. At least 90 per cent of the seeds of corn, cotton, or oats should germinate.

With small chaffy seeds like those of tomatoes and some grasses, we do not expect so many good seeds. But if Mary's notebook shows only 40 sprouted seeds among the 100 tomato seeds that she tested, we may be sure that such a sample is unfit for planting.

**Getting rid of poor seed.** — Suppose Tom's notebook shows only 70 sprouted grains out of the 100 kernels of oats that he placed in the germinator. He may carry home the message that this sample contains too many worthless seeds to afford a good stand. His father will probably show him how to fan or winnow oats so as to blow out many of these light, worthless seeds. *Fanning machines* are made for fanning and sifting out light and very small seeds.




Courtesy of U. S. Department of Agriculture

FIG. 10. — CORN GRAINS PLANTED AT VARIOUS DEPTHS IN A BOX WITH GLASS SIDES

In a later chapter about corn you will learn how to pick out by sight and avoid for seed those ears that have many grains not able to sprout.

### PRACTICE WORK AND QUESTIONS

1. **To make a plate seed tester.** — On a clean china plate spread a piece of clean thick cloth. In the bottom of the plate lay two small sticks to lift the seed that will be placed on the cloth out of the water with which the bottom of the plate is to be kept covered. Let the ends of the

cloth lie in the water so as to keep the entire cloth damp. Place the several lots of seed on different parts of the cloth. The seeds in each lot should be some even number, such as 10, 50, or 100. Carefully cover the seeds with another cloth, also kept damp, and place over the whole a second plate to prevent too rapid drying. Place the tester and its contents in a room that does not become very cold. Examine the seed and count on the fifth and eighth days, or oftener, how many of the seeds have germinated. Write in your notebook each time the number that have sprouted. Clean blotting paper may be used instead of cloth.

2. **To make a rag-doll seed tester.** — To test a number of lots of seed at the same time, a rag-doll tester is convenient. To make this, cut a strip of heavy white cotton cloth about one foot wide and several feet long. Tack one end to a stick or piece of lath, somewhat longer than the cloth is wide. With a pencil rule squares on one side of the cloth. The lines making the squares may be 2 or 3 inches apart. Number each square. Thoroughly dampen the cloth with clean water. Carefully place the first lot of seed on square No. 1, the second on square No. 2, and so on. Write in your notebook the name of owner of each lot of seed and the number of the square on which his seed are placed.

Next cover all the seed with a piece of damp cloth similar to the first, but unruled. Turn the stick so as to wind the damp cloth on it, being careful not to let any seeds slip from their proper square. When the whole of the cloth is wound, tie with a string and stand the tester on end in a shallow pan of water, letting the lower part of the rolled cloth touch the water. Later unroll the cloth carefully, count sprouted seeds, and make records as in the plate tester.

3. Select ten grains of corn having the largest germs, as shown by the size of the depressed area. Select ten others with the smallest possible germs. Which grains would you expect to make the largest, strongest young plants and to be best able to push up if covered rather deeply?

4. Pick out the largest and the smallest seeds of wheat, radish, or peas. Place samples of both in different parts of the germinating box or plate and notice which produce the larger shoots.

5. Does Fig. 10 suggest any reason why good seeds sometimes fail to grow?

## CHAPTER IV

## WATER AND FOOD FROM THE SOIL

In order that plants may grow they must obtain water from the soil and food from both the soil and air. They must form all parts of the plant out of what they get from the soil and air.

FIG. 11. — EXPERIMENT TO SHOW THAT WATER IS THROWN OFF FROM THE LEAVES OF GROWING PLANTS

**The need for water.**—The greater part of the weight of growing plants consists of water. You know that animals throw off through the skin considerable amounts of water as perspiration, or sweat. In somewhat the same way plants throw off through their leaves extremely large quantities of water. A clover plant has given off in one day twice its weight of water. A crop of hay on one acre producing two

tons has used during its growing season more than six hundred tons or wagonloads of water. Speaking generally, cultivated plants require nearly four hundred times as much water in a season as the weight of the dry substances in the crop.

We can not see this water that passes through the plant because the leaves get rid of most of it in the form of water vapor, which is invisible like the moisture in one's breath. But just as the moisture in the breath condenses and becomes visible in very cold air, so we can arrange an experiment to condense the water vapor thrown off by leaves. (See Fig. 11.)

**Water comes from the soil.** — In periods of dry weather have you not seen corn and other plants wilt for lack of enough water? Then rain came, and you noticed that the leaves became plump and fresh. You may have thought that a part of the rain water entered the leaves as it fell. But growing leaves can not absorb or drink in water as it falls on them, or even when they are soaked in water. The plant obtains its water only through its roots and not directly from the falling rain or from dew.

**Plant food from the soil must be dissolved.** — No solid matter can enter a plant. Hence no part of the soil can act as food until it has been dissolved.

Sugar and salt, as you know, dissolve in water, and just so certain substances in the soil go into solution. The soil solution is very weak, so weak that it will usually take several thousand pounds of water to carry to the plant one pound of lime, phosphate, or any other single plant food. In later chapters you will learn what foods certain plants require and also how the farmer adds these to any soil that is too poor to supply to the plant the needed nourishment.

**Four most important elements of plant food.** — Fortunately for the farmer and for the food supply of the world, the plant obtains more material for its solid substance from the air than from the soil. However, there are at least ten elements that plants draw from the soil. All but four of these are nearly always present in the soil in quantities sufficient to supply our crops for hundreds of years.

The four plant foods or elements that are often not sufficiently abundant in the soil are nitrogen, phosphorus, potassium, and calcium. We may call these the precious elements, for they are more important to the plant and to the farmer than silver and gold. Besides, the farmer often has to buy them, paying silver and gold for them.

These four elements exist in the soil in combinations; we speak of the potassium combinations as potash, and of the calcium combinations as lime. In any particular soil only one of these four elements may be insufficient; in another soil there may be a lack of two of them; in a third three of them may be deficient; and in yet another soil all four of them may need to be supplied. If a single one is lacking or insufficient in quantity, there will be a failure of the crop, no matter how abundant the other three may be. So it happens that a farmer may buy phosphates and potash and furnish these freely to his crops and yet have them fail because nitrogen or lime may be lacking.

**Root hairs.** — The large roots which are easily seen when you pull up a plant are not the ones that absorb water from the soil. If you will examine carefully the roots from a grain of corn, you will notice that the slender roots are covered with a white coating like velvet. (See Fig. 12.) These white threads are root hairs. It is the business of

each of these short velvety threads, or root hairs, to absorb moisture and dissolve plant food from the soil.

Root hairs are tiny little workers that have to furnish all the water a large plant needs. There are thousands of them on every large growing plant. Root hairs can be found only near the tips of young roots. They are so slender that they can push in between the particles of sand and clay and absorb moisture from all the moist soil grains that touch them. It is important, therefore, to retain the small or young roots on trees or other plants that are to be transplanted.

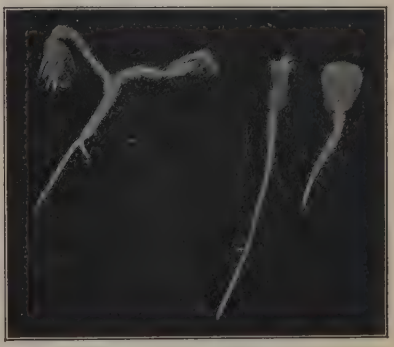


FIG. 12. — ROOT HAIRS GROWING ON ROOTS OF CORN

**Roots help to dissolve soil.**—Roots give off small amounts of a weak acid which dissolves more of the plant food in the soil that the roots touch than can pure water. The food dissolved by acid is added to that already dissolved from the soil by water, and the mixture is drawn into the cells of the plant and carried up through the stem, the greater part directly to the leaves. There it is mixed with the substances the leaves have taken from the air. The result of this digestion and mixing is a liquid called *sap*. This sap is slowly distributed to all parts of the plant, to be used in making leaves, stems, roots, flowers, and seeds.

**How plants lift water.** — What force enables plants to collect water from the ground and lift it into the roots and

stems? To understand this we need to study the tiny cells of which every part of the plant consists. We may think of a cell as a tiny room, too small even to be seen without a powerful microscope. But this little room or cell has no doors or windows or other openings in it. It is completely lined on the inside with a layer of living jellylike material. This layer lets water and the plant food dissolved in water soak through it and thus pass to the inside of the cell. An important fact to remember is that the water passes into the cells of the root hairs, but that it will not pass out into the soil again while the plant is healthy. This is because the watery solution in the soil is more dilute than the sap which fills the plant cell. This flow of water toward the denser liquid in the plant cells helps to force water upward from the roots. The leaves assist in the upward flow, for water must rise to take the place of that which the leaves give off into the air.

**The water current.** — If you cut off a branch of a grapevine as the buds are swelling, you will notice in a few days that the wound has "bled," that is, water has been forced up to and out of the wound. When we speak of the sap rising in the spring, we mean that the roots have begun to force water upward. The current of liquid rising from the roots and soil soaks through tiny canals in the stem up to the leaves. In trees the tubes that carry water from the soil *upward* are located in the *sapwood*, while those that bring the sap *downward* from the leaves to build up all parts of the plant lie *between the outer bark and the sapwood*. As soon as the leaves appear on trees, the real sap will flow downward in this inner bark, or cambium, at the same time that the water from the soil continues to rise through the tiny channels nearer the center of the stem.

Likewise in tomatoes and other smaller plants the upward current of liquid is carried from roots to leaves by tiny tubes or series of lengthened cells well within the stem; while the descending current of real sap moves from the leaves downward in other tubes located in a layer of the stem that corresponds to the inner bark of trees.

### Practice Work and Questions

1. Germinate seeds of radish or corn, or use seedlings already germinated in previous lessons. As soon as the root hairs develop, make a drawing to show them.

2. In a safe place carefully burn one pound of dry hay. Note the small proportion that is left in the form of ashes. The ash, with a small amount of nitrogen (that was burned off), was all the food that the plant obtained from the soil.

3. **To show that water in the soil dissolves plant food.** — Make small holes in the bottom of a tomato can. Fill the can with closely packed soil from a garden or lot. Pour rain water on this soil very slowly. Catch in a tight can or jar the water that drips from the rich soil, and strain it.

Into a similar jar or can, pour pure rain water. In both jars place a few sprouted seeds floated on the surface on a thin layer of cotton or on small wet chips. After the roots have grown to some length, note that they are largest in the water that has been in contact with the soil. Why?

4. **To show that liquids are carried upward in the stem of the plant.** — In half a tumbler of water colored with a tablespoonful of red ink, place the roots of a young plant of corn or bean and clean-cut short leafy twigs of geranium or willow. The next day cut through the stem of each at various points and note the streaks of red color, showing that the liquid has been drawn upward into the plant stems. Note the position of these colored streaks. Soil water is likewise lifted through the stem.

## CHAPTER V

## HOW PLANTS GET FOOD FROM THE AIR

In this chapter we are to learn about the most wonderful factory in the world. This is the green leaf. It is wonderful because it employs the most powerful engine in the world, the sun itself.

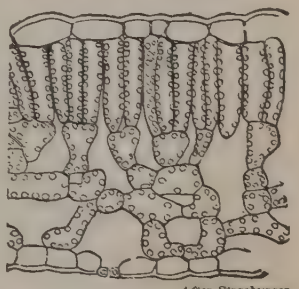
The manufacturing carried on in the green leaf is the most important in the world. If the leaves should stop work, every part of every plant would die and there would be no food for animals, and no food, fuel, and clothing for mankind. So we must try to understand how the leaf performs the work of food making on which we are all entirely dependent.

**Plants breathe air.** — You have doubtless learned in studying physiology how persons and animals breathe. They take the air into the lungs and the oxygen gas which it contains is there removed for use in the body. If land animals, including human beings, remain long under water, they drown, because the supply of air is cut off. Likewise ordinary plants die when their leaves or roots are kept long under water, because they are thus deprived of sufficient air.

Plants, like animals, take in or "breathe" fresh air. Men and animals take oxygen from the air for use in their lungs and give back a gas called carbon dioxide, which is composed of carbon and oxygen. This gas is injurious to

animals and man but plants could not exist without it. Plants draw in air chiefly as a means of getting carbon dioxide though they also require some oxygen.

**Leaf "mouths" for the entrance of air.** — Before considering the work done by the leaves, let us learn how the air gets to the working cells within the leaf. Leaves, even the thinnest, are made up of several layers, each of which consists of a great number of tiny cells. In the outer layers of the leaf these cells lie close together so as to cover and protect the layers of more loosely arranged inner cells. (See Fig. 13.) In these thin outer layers of the leaf are great numbers of tiny openings. These are mouths or gateways for the entrance of air into the inside of the leaf. These openings are much more numerous on the under side of a leaf than elsewhere. They are too small to be seen with the naked eye but are so numerous that together they are able to admit into the leaf all the substances that the plant takes from the air. Through them also passes off into the air the extremely large amount of water brought to the leaves from the roots and not needed in the making of sap.



*After Strasburger*

FIG. 13. — A CUT EDGE OF A LEAF HIGHLY MAGNIFIED

These gateways are so arranged that they can be opened or closed according to the plant's need. When the weather is very dry, the openings partly close to keep the moisture from passing out of the leaves too rapidly. What would happen to the leaf if these openings could not be partly closed when the weather becomes very dry and hot?

**Absorbing carbon dioxide from the air.** — After the air with its mixture of carbon dioxide gas enters the *stomata* or pores in the outer covering of the leaf, it comes in contact with the more loosely arranged cells on the inside of the leaf. These cells absorb the carbon dioxide gas and mix it with the crude plant food brought as a thin solution from the roots to the leaves.

**A factory run by the sun.** — Now begins one of the most interesting and important operations in all nature. This is the making by the leaf of starch, sugar, and a wonderful substance called *protoplasm* out of the carbon dioxide of the air and the water-borne materials from the soil. The furnace that furnishes heat and energy for this manufacturing process in the leaves is the sun. It does not operate like the fire box of a steam engine by changing water into steam. Instead the sun's rays are largely absorbed by the green coloring matter, called *chlorophyll*, in the leaves, and this chlorophyll is just as necessary for making food material in the leaf as water is for the work of a steam engine.

All the processes are not thoroughly understood, but it is known that the light and heat of the sun absorbed by the green coloring matter enable the leaf to tear apart the carbon and the oxygen that together make up carbon dioxide gas and to manufacture starch and other complete food materials out of the separated carbon and the watery crude material brought from the soil. Let us remember that neither plants nor animals nor mankind could exist without the starch, protoplasm, and other foods thus manufactured in the leaf by the action of light on chlorophyll.

**Plants need light.** — The main fact to be remembered is that the green leaf gets its power or energy for making food from the light rays which its green material absorbs. The

food factory of the leaf does not operate at night. Darkness stops the manufacture of food.

From the above facts you can now see that green plants need sunlight. You can now understand one of the reasons why corn shaded by larger weeds or by trees becomes pale and sickly, and why most plants grow more rapidly and with greener color during fair weather than when clouds cut off the sun's rays day after day.

**Partial shading sometimes useful.** — While every green plant must have some light in order to grow or to remain healthy, some plants, such as lettuce, cauliflower, and fern, need smaller amounts of sunshine than do cotton, sugar cane, and corn. Therefore, we plant ferns on the north side of a house.

Sometimes cauliflower and lettuce are grown under partial shade, made by using white cloth, or wooden slats to cut off about half the sunshine or by putting whitewash on the roof of the greenhouse in which they grow. Partial shading makes such vegetables more tender, but it admits enough light for the leaves to perform their work of food making.

### Practice Work and Questions

1. In the middle of a hot, dry day notice a field of corn. What position does one of the large green leaves take? Do the edges roll upward or downward? There are special cells in the corn leaf whose work it is to roll the leaf when water is scarce. Do you think this rolled position increases or decreases the loss of water from the leaves?

2. Coat both sides of all the leaves of a small growing plant, such as a geranium, with a layer of grease or vaseline. Does the plant continue to thrive? What do the coated leaves lack? Why?

3. Examine grass covered by a board or straw, or a potato shoot grown in a dark room, to note that the absence of light has prevented the formation of green color and left the leaves and stem white and unhealthy.

Do young corn plants grow if we accidentally throw soil over all their leaves when cultivating the crop? Does the farmer kill small weeds by covering them with earth as he cultivates the crop?

4. If a reading glass can be secured, focus its rays in bright sunlight on a little water in a teaspoon. After a short time the water bubbles and boils in the spoon. Where did the water get the heat or energy for this movement?

In the same way plants obtain energy from the sun to run the food factories described in this chapter.

5. Cover a small plant growing in a can or out of doors with a can or box to keep out the light. A few days later compare the color and growth of the covered plant with those of uncovered plants. Why the difference?

6. In a hard head of cabbage or lettuce what is the color of the outer leaves? Of the inner leaves? What caused this difference?

If there are half-grown lettuce plants in the home garden fold the outer leaves closely around the inner ones and tie them loosely but so as to keep the light from the inner leaves. After a week or longer record in your notebook the change in color that you then see.

Are the stems and the tips of the leaves of celery of the same color in the bunches sold in grocery stores and grown in a few Southern gardens? The stems were at first green and the grower bleached them by heaping soil about them.

## CHAPTER VI

## THE PARTS OF THE FLOWER

The chief effort of the plant is to produce seed. A flower must be formed before the seed can develop. Its beautiful colors, its nectar, and its delicious perfume are means of attracting insects whose help it may require in making seed.

**Mustard flower.** — As our first example, we may inquire what are the parts of a mustard flower (Fig. 14). In the center of this flower is a column, at the top of which is a rounded knob (*o*, Fig. 15). The whole central column is called the *pistil* (Fig. 16). Its important parts are the *ovule case*, near the base, in which the seeds develop; and the *stigma*, or knob, at the top. In some plants the stigma is divided into several parts. The surface of a full-grown stigma is sticky or rough so that *pollen*, which is the yellow dust of the flower, may stick to it. The ovule case, or *ovary*, contains little, immature, seedlike bodies, called *ovules*. Each ovule may become a seed. But before an ovule can change into a seed, it must be fertilized; that is, a grain of

Fig. 14. — Flower of Mustard

pollen must fall upon the stigma and grow down into the ovule, after which the latter becomes a seed.

In a circle just outside of the pistil are a number of slender stalks (six on the mustard flower), called the *stamens* (1, 4, Fig. 15). The most important part of a stamen is the cap at the top. This is the *anther*, or pollen case. When the anther is mature, it bursts and frees a yellow powder, called *pollen*. Soon after this powder or pollen is shed, the stamen, now useless, dies. The pollen must be carried by insects or wind or otherwise to the sticky or rough surface of the stigma in the same or in a different flower. If pollen is not brought to the stigma, no seeds develop.

FIG. 15. — THE PARTS OF THE MUSTARD FLOWER

In a layer just outside of the stamens is the bright-colored part of the flower (2, Fig. 15). This is called the *corolla*. In many plants, as in the mustard, it is divided into a number of distinct pieces, each being really a colored leaf, called a *petal*. Fig. 14 shows that there are four petals in the mustard flower. Just outside of these are the green parts of the flower, called *sepals* (3, Fig. 15).

Let us see whether most flowers have their parts arranged in the same order, the pistil in the center, the stamens around the pistil, the petals next to these, and outside of all, the sepals.

FIG. 16. — A PISTIL

**Peach blossom.** — The peach blossom has this same arrangement. Examine one to see the undivided pistil. This is the part that a fruit grower examines after a frost, for he knows that if the pistils are killed there will be no peaches. Notice that there are numerous stamens, five petals, and five sepals, grown together.

**Apple blossom.** — The apple blossom (Fig. 17) is very much like that of the peach, but its pistil is divided into five parts. Like the peach it has five petals and five sepals.

**Cotton flower.** — The cotton bloom is formed on the plan of fives (Fig. 18.) There are five showy petals and also five short sepals. These last grow together and form a shallow cup, which incloses the base of the boll. The three large green parts that form the "square" are not sepals, but *bracts*, or leaflike extra parts. You also find bracts around some other flowers, for example, around the strawberry blossom and the head of the sunflower.

FIG. 17. — FLOWERS OF THE APPLE

There are usually four or five divisions of the pistil in the cotton bloom. From the number of these you will find that you can foretell how many locks or small masses of cotton there will be in any boll; for there will be just as many locks in the boll as there are divisions of the pistil.

The stamens in the cotton bloom are numerous. Their lower parts, or stalks, grow together to form a tube surrounding the pistil.

**Tomato bloom.** — The tomato bears a yellow star-shaped bloom. The large stamens stand close against the short

central pistil, hiding all except its tip. The tomato belongs to the *nightshade family*, which includes also the Irish potato, pepper, eggplant, tobacco, and a number of weeds, for example, horse nettle and Jimson weed.

FIG. 18. — SECTION OF A COTTON BLOOM

**Plant families.** — Plants that produce blooms are divided into more than two hundred families. A family of plants generally includes the kinds that form their flowers in the same general way. For example, the *bean family* includes the garden pea, the sweet pea, the field or cowpea, the locust tree, all kinds of clovers, and many others. If you will pick from a clover head a single tiny flower, you will see that its parts have the same general shape and arrangement as the large flowers of the garden pea, of the cowpea, or of the beautiful sweet pea.

Perhaps you can find out what resemblances there are between the flowers of the blackberry, the strawberry, the apple, the pear, the peach, the plum, and the wild rose. These all belong to the very large *rose family*, which includes most of our fruits and berries.

FIG. 19. — OAT FLOWER OPENED TO SHOW STAMENS (S) AND STIGMAS (St), ENLARGED (After Roberts and Freeman)

It will be easy for you to find scores of plants that belong to the immense *grass family*. After carefully examining several well-known grasses, like crab grass, examine plants of corn and oats (Fig. 19) and see how many resemblances to grasses you find in these useful crop plants. These and other grains belong to the grass family.

**Length of life.** — There are some plants the seed of which must be sown every year as oats and corn. These are called *annuals*, because they live during only one growing season. Plants that live two years are known as *biennials*. A third class consists of the *perennials*, that is, plants that live for more than two years. Bermuda grass, alfalfa, and all trees are examples of perennial plants.

### Practice Work and Questions

1. Collect as many large flowers as you can; point out (*a*) the pistil, (*b*) the stamens, (*c*) the petals, (*d*) the sepals. Find the pollen in all the flowers you examine. Does it show in young flower buds? Why is there little or no pollen in flowers that are nearly ready to wither or drop?

2. If the yellow blooms of turnips, collards, or cabbages can be found, compare their flowers with the illustrations of the mustard flower to see whether they are much alike. All these plants belong to the same family.

3. What a game the pupils can make of their class period in agriculture! Which of you will be the winner by bringing to class the largest number of different kinds of colored blooms of wild and cultivated plants?

Then group together all of those flowers that have the same kind and number of flower parts as any plant mentioned in this lesson; also make groups of any other flowers that resemble each other. Kinship among plants depends more on the number and arrangement of the parts of the flower than on resemblances in color.

When you enter high school or college, you can study *botany*, which tells the fascinating tale of how plants grow.

## CHAPTER VII

## POLLINATION

While you have been learning the names of the different parts of the flower, you have perhaps been thinking about the uses of each part. The sepals and petals serve to protect the more important parts inside. For example, the peach sepals and petals while still folded together in the bud keep the pistil from being killed by slight frosts in the early spring; thus the peach crop is sometimes saved. That the stamens and pistils (Fig. 20), however, are more important than the sepals and petals can be proved by carefully removing all of the petals from a flower of cotton or from a peach blossom. In spite of this injury, a boll or a peach will form if pollen is applied to the stigma.

FIG. 20. — PISTIL AND STAMENS OF A TULIP

**Flowers without petals.** — Since the flower makes seed or fruit by means of the stamens and pistil alone, these two parts are called the necessary or essential parts. The flowers of many plants have no showy sepals and petals. The sepals and the petals are not strictly necessary. When you see the flowers of corn and wheat you may not think of them as flowers, because they have no gay colors. The bees and other insects do not often visit such flowers.

**Function or use of the pistil.** — The pistil is the part of a flower that develops into the seed case, or fruit. In its base it contains the tiny ovules which may develop into seeds. There will be no fruit or seed formed if the pistil is destroyed.

**Function or use of pollen.** — The part of the stamen that is most important is the pollen, or plant dust. This is a fine powder and is set free by the opening of the little pollen case, or *anther*, at the tip end of the stamen. Pollen adheres to and grows into the pistil; this is called *pollination*. The tiny tube that the pollen grain sends down through the pistil finally reaches and enters the ovule at the place where a seed will later be found. This growing together of pollen and ovule is called *fertilization* and is necessary before a seed can develop. It has nothing to do with the fertilizing of plants by supplying them with fertilizer. You may learn the importance of the pollen to the plant by carefully picking off all the stamens of a nearly open flower bud of cotton or peach or other plant. Then tie a small paper sack over the injured bloom to keep the pollen of other flowers from being brought in by wind or insects. In a few days you will find that the pistil to which no pollen can gain access does not grow but generally dies and falls. If it lives, it produces no perfect seed, but other pistils, on whose stigmas tiny grains adhere, will grow.

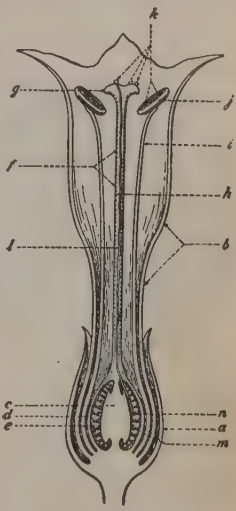



FIG. 21. — DIAGRAM OF A TOBACCO FLOWER

If you tie a paper bag tightly over a young corn ear before the silks show and keep it there, no grains will form on that cob. This is because no pollen falls on the silks, which are the pistils of an ear of corn. For the same reason, if you cut the young silks from one side of an ear shoot, no grains will grow on that side. Every silk is connected with a grain space on the cob, and if that silk catches no pollen, a vacant grain space is left on the cob where this silk arises.

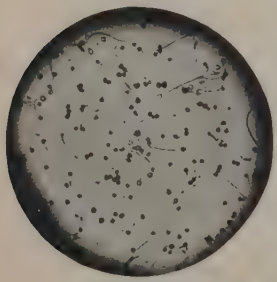


FIG. 22. — POLLEN GRAINS
The lines show how they grow towards the ovary.

Pollen does not cause fruit or seed to grow, or be produced, unless the plant that bore it is of the same kind as, or closely related to, the plant on whose pistil it is placed. Thus peach pollen is useless on apple blossoms. The pollen may come from the same bloom of which the pistil is a part, from another flower of the same plant, or from a different plant of the same kind.

**Self-pollinated plants.** — In the flowers of wheat, oats, and peas the pistil is usually pollinated by the pollen that is produced in the same flower. Such plants are said to be self-pollinated. Self-pollinated plants do not mix with other kinds in the field.

**Cross-pollinated plants.** — On the other hand, the pistils of some kinds of plants usually receive pollen that grows on a different plant. Such plants are said to be cross-pollinated. If a farmer grows a white and a yellow variety of corn side by side, these will be mixed in a few years. This is because the light pollen dust from one kind is carried by

the wind to the silks of the other. Many a boy has had his patch of pop corn ruined by planting it near field corn that bloomed at the same time as the pop corn. You have perhaps noticed the pollen of corn, as it was carried by the wind, like fine dust. You have probably also observed in the spring clouds of yellowish dust blown from the pine trees. This dust is light pollen carried by the wind.

**How insects help the flowers to form seed.** — Some plants have heavy pollen, which the wind can not carry so easily. Cotton is one of these. Such plants usually have gayly colored petals that attract the insects. Even children like to taste nectar by touching the tongue to a blossom of honeysuckle after its petals are removed. The flower offers nectar to insects and in return the insects usually bring pollen from a blossom of the same kind and place this on the pistil. If we notice a bee as it enters a flower, we observe that much yellow dust adheres to its body. This is pollen that it rubs against while visiting flowers. While the bee is in the blossoms, it usually happens to brush against the sticky or rough stigma, which catches some of the pollen it brings. It is interesting to watch the movements of the insects when they are thus helping the flower to form seed.

Fig. 23. — Flower of Strawberry with both Pistils and Stamens

Gardeners who grow tomatoes in the greenhouse sometimes collect the pollen and place it on the flowers by using a brush. If they fail to do this, they will get very few tomatoes. If there are many large insects in the greenhouse, they need not take this trouble. We do not need to practice this hand pollination when tomatoes are grown in the garden,

for then insects do this useful work instead of human hands.

In one locality the fruit growers thought that bees were injuring their ripe fruits, and they accordingly made the keepers of bees remove their hives. As a result the fruit crop decreased. Then the bees were brought back, and the crop at once increased. If the weather, when fruit trees are

FIG. 24. — A CLUSTER OF NINE PEARS WHERE BLOOMS WERE SUPPLIED WITH POLLEN OF ANOTHER VARIETY (on left); SAME VARIETY SELF-POLLINATED SHOWS TWO PEARS IN CLUSTER (on right)

in bloom, is so cold or rainy that the bees do not fly from flower to flower, the crop of fruits is usually small.

Cross-pollinated plants (those that need to get pollen from other plants of the same kind) may be divided into two classes: first, those whose pollen is carried from one plant to another by wind; second, those whose pollen is carried by insects.

**Why strawberries sometimes fail to bear.** — A gardener

once had a well-worked strawberry bed that showed a mass of leaves and runners, but yielded few berries. This was because he had planted only one variety, which did not have well-developed stamens. His patch of strawberries would have borne good crops if he had planted every fourth row with another variety having stamens as well as pistils. From this you see that it pays to know something about how plants are supplied with pollen. Varieties of strawberries without developed stamens are called *imperfect* varieties, and the kinds with pistils and good stamens are called *perfect* varieties (Fig. 23).

*Courtesy of Georgia Agricultural Experiment Station*

FIG. 25. — CLUSTERS OF GRAPES
Self-pollinated on left; cross-pollinated on right

**Why the fruit crop sometimes fails.** — Even when the flowers contain both stamens and pistils, there is often a failure to produce fruit. This is likely to happen when a single variety of grapes, pears, or apples is planted alone and away from all other sorts of the same fruit. Some varieties of these fruits must get pollen that has grown on a different form. The pollen of a Duchess pear, for example, when it falls on the pistils of a Bartlett blossom will cause fruit to grow; but usually no pear develops when the pollen from a Duchess pear falls on the pistils of a Duchess blossom. Trees or

grapevines that act thus are said to have pollen that is impotent (powerless) on blossoms of the same variety. Impotent pollen is one of nature's many ways of preventing self-pollination (Figs. 24, 25, 26).

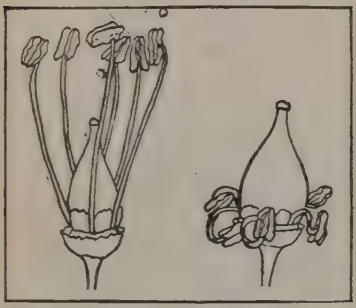


FIG. 26. — GRAPE FLOWERS ENLARGED
On right, curved stamens with imperfect pollen; on left, upright stamens of a self-fertile variety, Concord.

In planting strawberries, grapes, apples, pears, or pecans for home use it is a good rule to plant several varieties of each so that one may supply pollen for the blossoms of the others.

**Pistils and stamens in different parts of the same plants.** — We have called the pistils and the stamens the essential parts of a flower because both are necessary to the formation of the seeds. When one flower bears both stamens and pistil, it is called a *perfect flower*. But the pistil and the stamens are not always found in the same flower. In the corn plant, for example, the silks are the pistils, while the stamens from which the pollen comes are in the tassel, another part of the same plant. Thus you see that in corn the staminate flowers are borne on the top of the plant and the

FIG. 27. — CUCUMBER FLOWERS
On left is shown a pistillate flower: on right, a staminate.

pistillate on the young ears of corn growing on the stalks of the same plant.

On a squash, cucumber, or watermelon the pistillate blossom may be known by the little squash or melon which shows below its yellow petals. These blossoms have pistils but no stamens. In other parts of the same plants are staminate blossoms, that have stamens but no pistils and no swollen part. Among other plants having stamens and pistils borne on the same plant, but not in the same flower, are the castor bean, the oak, and the pecan.

**Pistils and stamens are sometimes on different plants.** — This is the case with hemp, willows, and poplars. The clusters that bear the stamens soon fall; those bearing pistils remain to perfect the seed.

### Practice Work and Questions

1. Carefully remove the shucks from an ear of corn, preferably soon after silking, though mature ears may be used. To what is the inner end of each unbroken silk fastened? Are there any unfilled spaces on the cob? Why?

2. If blooms of cotton, okra, cowpea, or tomato can be found, examine the young flowers to see whether the pollen is so light as to be borne easily by wind or whether it is so heavy and sticky as to need insects to carry it to other flowers.

3. Tie paper bags or pieces of tough paper snugly around the unopened buds of any kind of plants that may be blooming when you study this lesson. In a week note whether the pistil is growing and seeds are forming. If so, these plants do not need visits from insects but are self-pollinated. Observe what flowers are being visited by insects and especially by honeybees. Note the kinds of insects. Watch them to learn whether they brush off any pollen of another flower against the pistil.

4. If cotton or okra is in bloom, conduct the experiment described on page 47, applying the pollen of one plant or flower to the stigma of another.

5. **Home project.** Would you like to learn how fast a bloom on one of your tomato plants grows into a tomato? What members of the class will prove persistent enough to get the answer to this question? Tie a small pasteboard label loosely to a stem where you have noted a newly opened tomato blossom. On the label write clearly with pencil the date when the bloom was new. Also write this date in your notebook. Later write in your notebook the date the blossom drops or dries and the dates when the young tomato reaches the size of a marble and then of a walnut; also when it begins to color and when it is ripe. What an interesting record you will then have to report to your parents and to the class!

You may use instead for the same experiment a flower of cotton, bean, cowpea, peach, or of any other plant. It is best to label several blooms, as some may fall.

## CHAPTER VIII

## IMPROVEMENT OF PLANTS

Our valuable cultivated plants have been developed from poor or useless wild plants. The tomato, for example, bore very small and worthless fruits, and the cultivated rose was once a wild rose with few petals. Greatly as man has improved plants in the past, recent discoveries of some of the laws of improvement should make future progress still more rapid.

**Selection.** — By selection, or choosing seeds from the most desirable individuals, plants may be slowly changed. Selection is the easiest, surest, and usual method of improvement. In plants and animals the general rule is that the offspring resembles the parents and grandparents. But among the five hundred or more stalks grown by planting the kernels of a single ear of corn, there may usually be found several that have larger ears than others from the same ear. All crops may be made more productive by using seeds from a small seed plot that is planted every year with the seeds from the best plants of the year before.

In selecting we may, for example, take a variety of corn that has usually produced only one ear and select the few plants that have several ears. If we plant these seeds by themselves and from that crop again select the stalks with the most ears, and so on every season, in a few years we shall

have a new variety in which most of the plants will bear several ears. This is improvement by selection. Even plants, such as potatoes, that do not generally produce seeds, have been improved by selecting the best hills for planting the next year.

**Select for one quality at a time.** — In improving a variety, change can be made most rapidly by selecting chiefly for one thing at a time. That is, we must decide, say in the case of corn, whether we would rather increase the length of ear, the length of kernels, or the number of ears to a plant. We may desire all three of these qualities in our new variety, but it would take many years to make the desired improvement, if we chose one plant for number of ears, another for length of ear, and a third for length of kernel and planted these seeds *together*. The better way is to find some variety of corn already existing that is really good enough to suit us in all qualities except one. Suppose it is desired to increase the number of ears on one stalk. Rapid increase in this case would come from selecting our seed ears only from plants bearing several ears. Among these several-eared plants preference would be given to those that have the other desirable qualities in the greatest degree.

FIG. 28.—RESULTS OF SELECTION IN WHEAT AFTER FOUR YEARS

**Mixture of pollen from inferior plants.** This improvement by selection can not be made if the ear selected is planted where the pollen from a field of poor, unimproved corn will be able to reach the silks. If some of the stalks in

the field are poor or barren, as shown by having no ear shoot, the tassels of such plants should be pulled off before the pollen begins to fall. The plants of field corn, of cotton, and of most cultivated plants do not show resemblance to the pollen-bearing parent the first season. The crop of common field corn does not suffer in *yield* the *first season* from a cross with inferior pollen. The next season, however, the corn from such crosses is poor, and even the best ears thus produced will not bear uniform offspring. Pop corn and sweet corn may show the change the first year.

**Temporary and permanent improvement.** — It is difficult to distinguish between temporary improvement and that which will be permanent through later generations. Usually an increase in the size of a plant due merely to one year of special fertilizing, watering, or extra space is temporary. The large size, it seems, is not inherited by the offspring. Improvement due to years of selection is, however, inherited (Fig. 28).

**Separate planting of best ears.** — Improvement is rapid if the offspring of *each* of the best plants is planted *separately*. It is best to plant each set of seeds in a separate row. Selection should be made for planting the seed patch the next year by choosing the ears from the most productive plants of the *best row* or seeds from the choice cotton plants of the *best row* of cotton. The most valuable plant for seed purposes is not always the plant that happens to be the largest, but rather the one that will produce productive offspring of good quality. This is the reason that in a seed patch *it is better to plant all the descendants of one parent plant together in one row*, so that the farmer may judge the parent by the average character of the offspring.

The farmer who would improve or "breed up" his corn,

cotton, wheat, oats, or other crop should have a special breeding plot or seed patch and should carefully observe each plant grown there. Sometimes it happens that there is a single plant that is decidedly superior to all the others, and seed of this "sport," or very unusual plant, may start a new and more valuable variety.

**Home-grown seed often best.** — Field corn from north of the Ohio River is earlier and smaller and in some parts of the South yields less than our native corn. If seed of corn grown for many years in a colder country is brought to the Southern States and seed from this variety planted for several years in the South, each year the variety becomes later and later and the stalks larger and larger.

If early vegetables are desired, make them earlier by getting seed grown far North where the plant has learned to be in a hurry to get ripe in a short season.

A change of seed should not be made unless there is good reason for it or unless better seed can thus be obtained. A crop suited to the South does not "run out" or grow worthless if properly managed. A plant usually becomes better fitted for its new home by being grown there for a number of years. Seed of field crops grown in nearly the same climate is preferred.

**Improvement by crossing plants.** – Sometimes the plant breeder must resort to crossing in order to unite in one plant the good qualities of two different varieties. Suppose, for example, he wishes to improve a variety of corn the ears of which are too small by using the pollen from a large-eared variety. Before the silk is seen on the mother plant, he must tie a paper bag over the ear shoot. Soon after the silks show, the plant breeder carefully pulls a tassel from a plant of the large-eared variety. The pollen should be just ready

to fly. He dusts this over the silks of a selected plant and repeats this process the next day, keeping the shoot under the bag until the silks dry.

He may wish also to cause a big-boll variety of cotton to grow a longer staple. Before the cotton bud or young bloom of the big-boll variety is ready to open, or about sunset or sunrise, the plant breeder opens or cuts away the upper parts of the white petals and with a knife, small

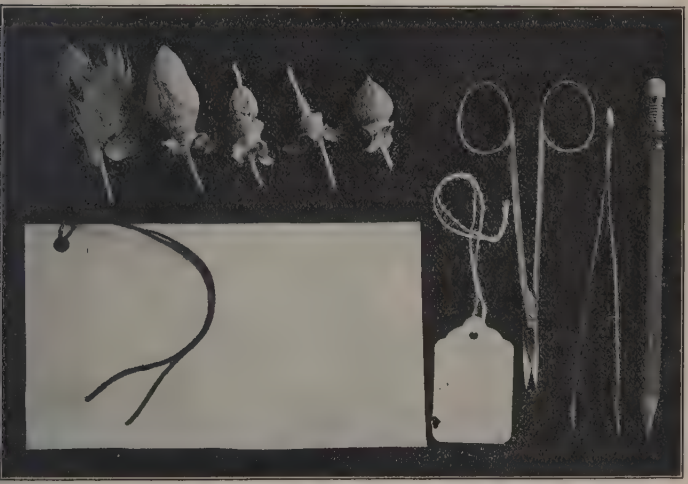


FIG. 29. — TOOLS AND METHOD OF PREPARING COTTON BLOOMS FOR CROSSING
On left, flower buds; in center, bud after removing of corolla showing stamens; on right, pistil from around which stamens have been removed and small boll which results from the crossing operation.

scissors, or fingers removes every anther or pollen case (Fig. 29). This is done before these cases have opened and spilled their pollen on the pistil of the same flower. A small

paper bag is now tied over the injured flower to keep insects from bringing any pollen to it. Pollen from a selected long-staple plant may then be used after the pistil is more mature. After most of the cotton blossoms have opened, or between eight and ten o'clock in the morning, our plant breeder comes back, removes the paper bag, and gently rubs over the top of the pistil a flower from a plant of the long-staple variety, of which the pollen is beginning to shed. The particles of pollen now cling to the sticky surface of the stigma and grow there. The bag is replaced and removed five days later, when, if all is well, a young boll is found. The seeds produced in that boll are the offspring of both varieties.

If, however, the thirty to forty seeds from that boll all grow into mature plants, the next year these sister plants will not be all alike. Some will resemble the big-boll mother plant; some will be like the long-staple father plant; some will be unlike either; and some may combine the likeness of both parents. The plant breeder must plant the seed, giving a separate row to the seed of each plant; for several years in succession he must select for seed the plants that come nearest to uniting the qualities that he wishes — large bolls and long lint. It will usually be best for the farmer to rely for improvement on selection alone, rather than on crossing.

**Cross-pollination usually better than self-pollination.** — Generally pollen is most effective in causing seed to develop when the pollen and the pistil are borne on different plants. When the pollen of a corn plant standing alone falls on the silks of the same plants, grains develop. But the plants grown from such corn grains are less vigorous and productive than plants from seed having two parents not closely

related. It is to avoid self-pollination that some seed breeders pull the immature tassels from the corn plants on the rows from which they intend to select their best seed corn.

### Practice Work and Questions

1. Farmers' boys can increase next year's corn crop by selecting a few bushels of seed from the best plants. Who will offer to do so?

2. When wheat or oats are ripe, remember, if you live on a farm, to watch for the best plants and to save seeds from a few of them for planting by themselves next year.

3. Have all the wild plants suitable for human use been cultivated and improved? Perhaps you will be the one to bring another wild forage plant or flower into use.

4. **Home project.** If you have not already grown as your very own a patch of corn or of some other field or garden crop, the first step is to select good seed. If your home project is to be the growing of corn, select the ears before they have been harvested. You need for planting good parent stalks as well as good seed ears. Before deciding what is the best kind of ear you should read Chapter XX.

Select only good ears that grow on the kind of plants you desire next year. Avoid stalks that have fallen or that bear ears very far from the ground; reject ears whose ear shanks are extremely long or colored by disease. In a variety commonly bearing two ears pass by even a good ear if it is the only ear on the plant.

In some farm paper read any article that you can find on selecting corn for planting.

## CHAPTER IX

## HOW THE SOIL WAS FORMED—KINDS OF SOILS

If we hammer a small piece of stone, we can usually change it into a powder. The tiny particles that make up this powder are often like some of the grains of the soil that may be found near the stone. What is now soil in ages past was solid rock. Far mightier forces than the heaviest of hammers cracked and ground these ancient rocks for thousands of years, until they crumbled into sand and soil. As the earth's surface cooled and shrunk and wrinkled, the rocks cracked. Water standing in these cracks and tiny rough places froze. In freezing the water expanded and thus broke off great and tiny pieces of rock.

Air and water, just as they eat slowly into iron, forming iron rust, so changed and dissolved some of the cementing material in the rock. Then the remaining parts of the large rocks crumbled.

**Water grinds rocks into soil.** — Streams of water rolled the sharp-edged pieces of rock against each other, grinding off the sharp points, making sand of the fragments, and leaving rounded stones and pebbles. When a boy wishes nice, smooth stones for his sling shot, he knows he will find them in the bed of a stream. While searching for smooth stones, he walks over a sand bar. This sand bar shows how

water-borne, or transported, soil was formed. It is made partly of fine gravel, partly of similar material ground into coarse sand, and of still finer material which is called soil. When the stream overflows, it sometimes forms a similar sand bar in the lowlands along its banks.

**Plants aid in forming soil.** — At first nothing grows on these sand bars in the field, but soon a few plants attempt to live there. When these decay, they serve as fertilizers, so that the next generation of plants is larger. After some years this sand bar may become fertile soil.

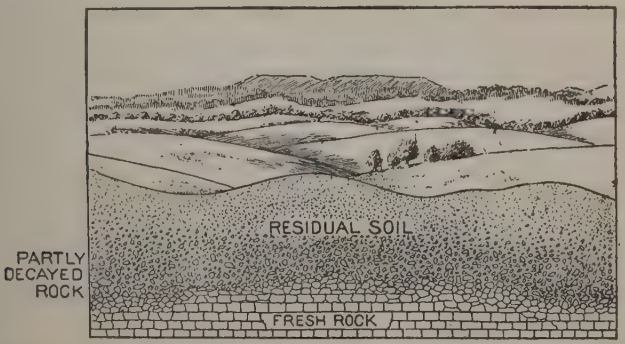



Fig. 30. — Diagram Showing Formation of Soil from Underlying Rock

Tiny plants, such as mosses and lichens, sometimes grow on bare rock. The roots of these not only dissolve the softer parts of the rock, but by their decay fertilize later generations of higher plants, until in time a shallow soil is formed in the pockets in the surface of the rock.

**Soil and subsoil.** — We see that soil is the finely divided surface layer of the earth in which higher plants can grow.

It consists of two portions, which are not always alike: (1) the looser upper layer, or *soil proper*, and (2) the more compact layer under this, called the *subsoil*.

The soil consists chiefly of sand and clay, but neither one of these is food for plants. Sand is useful in keeping soil from packing too closely and from being too wet and sticky. Clay is useful in holding moisture and cementing the sand grains together. A small part of the clay, under proper conditions, can finally be changed into plant food.

Much more useful to plants as food are the decaying remains of earlier generations of plants. These are usually spoken of as vegetable, or organic, matter, or *humus*. There is much more vegetable matter in the soil than in the subsoil. Hence the soil produces much larger crops than the subsoil can when it is first brought to the surface. This is because the vegetable matter in the soil supplies plant food, holds moisture, and makes the soil loose and mellow, thus permitting the roots and air to penetrate it. The subsoil, when first thrown up from the bottom of a ditch, is unsuitable for plant growth, but after it has been exposed to the air for several years, plants grow on this changed subsoil as well as anywhere else.

**Available and unavailable plant food in the soil.** — The soil contains all of the chemical elements found in plants and many more besides. All cultivated soils are rich enough in most of these elements; so only those elements or compounds which are sometimes scarce need be considered. These are nitrogen, phosphoric acid, potash, and lime. In a soil that yields poor crops there may sometimes be enough of all of these, but they may be held so tightly by the iron or clay that water can not dissolve and carry them into plants.

Such insoluble substances are spoken of as *unavailable*. These may be changed into soluble forms, or *available plant food*, by the oxygen of the air and by the decay of vegetable matter. To make the plant food in stiff soil or subsoil useful, therefore, the soil must be loosened with the plow, and the surplus water drained, thus letting in the oxygen of the air. Oxygen is called the restless element, because it is continually seeking change and causing other elements in the soil to change also.

**How decay of vegetable matter prepares plant food.** — The decay of vegetable matter in the soil helps to make the soil elements more soluble by loosening the soil, so that the oxygen of the air can reach all parts of it. It also helps because the carbonic acid formed during its decay is absorbed by the water in the soil; this mixture of water and carbonic acid has a much stronger dissolving power than pure water alone. The rotting of vegetable matter helps to soften, or *rot*, the hardest rock and stiffest soil. Of course the decay of former generations of plants also furnishes plant food directly to later generations.

**Soils not permanently exhausted.** — Even in a rich soil only a small part of the nitrogen, phosphoric acid, potash, and lime is in a soluble form. They become soluble very slowly and gradually, so that roots have near them a small but continuous supply of newly prepared food. This is well, for, if all these elements in the soil were in a soluble condition, a succession of heavy rains would dissolve and wash all the plant food out of the soil and carry it to the ocean. However, since only a small part of the phosphoric acid and potash of the soil are in a soluble condition, no soil can be permanently or completely exhausted. It is possible

to restore the fertility of any soil that has a fair proportion of clay in it.

**Clay and sand.** — Examine a little sample of clay soil and another of sandy soil. When you rub them between your fingers, the clay soil feels smooth, and the sandy soil feels coarse and gritty. Sand grains are hundreds of times larger than the tiny grains of clay. They are so large that they do not settle closely together, and the spaces between them allow water to run very rapidly through. Sandy soil, therefore, will not hold water well.

We can scarcely understand how small are the separate particles of clay. It would require more than fifty thousand fine particles side by side to cover a line one inch long. Since the grains, or particles, of clay are so small, they can be packed tightly together, leaving very little space between. It is difficult, therefore, for air and water to penetrate a clay soil.

**Granulation.** — Fortunately in well-cultivated and well-drained clay soils, supplied with vegetable matter, a number of the tiny particles cling together in one group, or *granule*. Each of these groups acts like a single sand grain, since spaces between granules are open enough for water to drain through and for air to enter. This *granulation*, or grouping into granules, is the condition the farmer wishes his clay soil to assume. If, however, he plows when the soil is too wet, the plow breaks up these groups and packs together the tiny particles that before formed a granule. Great clods are then formed and, in consequence, a single plowing when the clay soil is too wet may injure the field for many years.

**Coarse- and fine-grained soils.** — Soils may be arranged in the following order, according to the coarseness of the

particles of which they consist, beginning with the coarsest and ending with the finest:

| | |
|---|---|
| Gravel | Fine sandy loam |
| Gravelly loam | Loam |
| Coarse sand | Silt loam |
| Fine sand | Clay loam |
| Sandy loam | Clay |

The most satisfactory soils are those consisting of a mixture of sand and clay. These are called *loam soils*. They have enough sand to make them pulverize easily and drain well and enough clay to hold sufficient moisture for plants and furnish a gradual supply of certain kinds of plant food. The coarsest soils become "worn out" soonest. Clay soils usually last longer because they contain the largest amount of total plant food. They require more tillage, however, to make this plant food available.

**Treatment of sandy and clay soils.** — You have just learned that a clay soil must not be plowed when wet. But if a soil consists almost wholly of sand, plowing it when rather wet does little harm. After plowing a clay soil the large lumps must be broken with a harrow before they become dry and form hard clods. Live stock should not be allowed to pass over clay soil while it is wet because their tracks make clods, just as does plowing.

### Practice Work and Questions

1. Find what curious kinds of tiny plants are growing on the bare rock in some shaded spot, and bring specimens for other members of the class to see.

2. Dig into several fields to learn how deep is the mellow soil. What differences do you find between the soil and the harder subsoil?

3. Find a tree that has been blown down, or one from around the roots of which the earth has been washed away, and write in your notebook how deep the roots went into the subsoil. Do annual crop plants send their roots deep into most kinds of subsoil?

4. Dry and pulverize some of the stiffest clay soil you can find. Place part of it in one can or box and the remainder in another. Slowly add water until both are thoroughly moist. Then while wet, pound the soil in one vessel with the end of a piece of stove wood to imitate the tramping of animals. Let both lots of soil dry. Then examine to see whether the clods are any worse in the "tramped" soil.

5. In a tall, clear bottle place about two tablespoonfuls of very fine soil and about one tablespoonful of coarse sand. Fill the bottle more than half full of water and shake it vigorously. Promptly place it on a window sill or table in good light and watch to learn whether the large, medium, or small particles are the first to settle. Write in your notebook the facts observed.

Repeat the trial with soils of various degrees of fineness and with various mixtures. Do you find anything in this experiment that explains why, in an overflowed field, the soil nearest the stream is more sandy than that farther from the stream? Does this also explain why the ground next to the bank of a creek is sometimes higher than that farther back from the stream?

## CHAPTER X

## MOISTURE IN THE SOIL

The difference between a rich and a poor soil consists largely in the fact that a rich soil is usually able to retain enough moisture, but not too much; while the unproductive soil does not afford enough water for the use of the plant during periods of dry weather and becomes too completely saturated in wet weather.

FIG. 31. — EXPERIMENT TO SHOW THE HEIGHT TO WHICH MOISTURE RISES IN DIFFERENT SOILS

On left is shown coarse-grained soil; on right, fine-grained soil.

**Clay soils hold water.** — Soils differ widely in the amount of moisture that they can hold. Test this by filling two tomato cans of equal size with thoroughly dried soil, one of them with nearly pure sand and the other with the stiffest clay you can find. Pack both soils thoroughly, and gradually add equal amounts of water to each. Before any dripping from the clay occurs, water will have begun to drip freely from the sandy soil through the holes in the bottom of the tin can. Thus it is seen that clay will hold much more water than sandy soil.

**Capillary moisture.** — The water that drains away from the soil is called *free* water. It is spoken of as free because

it always flows toward the lowest point. If cans of soil are allowed to drain for a day or two, although most of the free water will be removed, the soils will still be moist. The moisture remaining in the soil is called *capillary* moisture. It is spread out over the surface of the soil grains in such thin layers, or films, that it can not collect in drops and drain away. If a bag of pebbles is dipped into a bowl of water, the water which adheres to their surfaces is capillary moisture. It forms a very thin layer. There may be millions upon millions of soil grains in every cubic inch of soil, and to cover every one of these over its entire surface with the thinnest possible coat of moisture requires a large amount of water.

**Movements of free and capillary moisture.** — The farmer endeavors to remove a part of the free water from the soil by drainage and to retain in the soil as much capillary moisture as possible. He desires the free water to drain away, because it occupies the spaces between the soil grains and thus keeps out the air, which is needed by the roots. Free water moves only toward a lower level; but capillary moisture, on the other hand, moves in any direction (Fig. 31) but always very slowly. This is an advantage, for if this moisture moved as rapidly as the free water it would rise to the surface and evaporate. The earth would then become so dry that plants would die.

It is also fortunate for the farmer that the capillary moisture moves toward the dryest soil. Thus root hairs, lying in contact with the sheet of water that wraps up one soil grain, absorbs a large part of this moisture, but its place is soon taken by capillary moisture which moves in from moister particles (Fig. 32).

**Air spaces check the movement of capillary water.** — The farmer's part in preparing the ground and cultivating the soil consists chiefly in controlling the movement of

capillary moisture. This moisture moves about only when the soil particles touch each other, so that the dry grain can borrow from the damp ones. If an air space occurs between two soil particles, moisture will not move across this. The soil best prepared for seeds or roots is one having no large air spaces between the particles — in other words, a soil that is well settled or moderately compact, but which has been loosened up some time before the seeds are planted.

The farmer first loosens his soil, then permits the lower layers to become settled, and later, after the crop begins to grow, he stirs the surface. The surface layer is stirred in order to make large air spaces, that will prevent the moisture a little deeper down from coming to the surface and being evaporated and carried off by the wind. Earthworms are found under logs, boards, and stones because these places are moist, while the ground around is dry. The moisture in the soil can not easily rise up through the logs, boards, or stones and evaporate. The gardener makes use of this principle when he places a layer of leaves over strawberries, potatoes, or any crop that he wishes to keep well supplied with moisture. He calls such a layer of leaves a *mulch*, which simply means a cover to protect the soil against evaporation. The farmer can not afford to place layers of leaves over his fields, but he can afford to make a mulch by using material that is already there. *He can make a mulch of the soil itself*, if the top layer can be made loose and dry.

FIG. 32. — MOISTURE ON ROOT HAIRS AND SOIL GRAINS, GREATLY ENLARGED

*e*, main root; *h*, root hair. 1, air space; 2, soil grain; 3, film of water surrounding soil grains.

### Practice Work and Questions

1. Repeat with several soils the "dripping test" given in the second paragraph of this chapter. Which of these soils is least in need of artificial drainage?

2. Hang a dry lamp wick or napkin folded into a roll in such a way that its lower end rests in a vessel of water. Note that the water rises in the lamp wick or napkin. This is capillary movement.

3. Soak a brick thoroughly, or until no more bubbles rise from it. Lay on it a dry sponge. Why does the dry sponge not suck up any water out of the brick? The sponge illustrates the loose dirt or mulch.

Now wet the sponge. Lay on top of it a dry brick. Does the brick suck up water from the sponge? The brick represents a dry crust, and its action in taking water away from the sponge illustrates how water is drawn up through a compact crust and wasted by evaporation.

4. **Home project.** Find out for yourself whether a loose mulch of cultivated soil keeps the soil below it moist. Do this by cultivating with hoe and rake a crusted spot in your plot or in the garden, leaving a cultivated layer about two inches deep. Let the crust remain unbroken on a small spot. After a number of days but before the next rain, examine the soil below both the cultivated and the crusted spots.

In other chapters you will learn that weeds waste immense amounts of soil water, which they throw off into the air from their leaves. This loss of soil moisture through the leaves is sometimes greater than that caused by evaporation from the surface of the ground.

## CHAPTER XI

## PREPARATION AND CULTIVATION OF THE SOIL

Before the seed is sown, the land is plowed. The main object of early plowing is to form a loose mellow layer of soil through which the roots can spread in any direction.

**When to plow.** — When the plowing is well done, the soil is broken into small particles. This will not result, however, if the soil is very dry when plowed, for then great lumps and clods are turned over. On the other hand the soil does not pulverize well if plowed when wet enough for it to stick together and to show a shiny polished surface on the furrow slice. Only experience will tell just how wet or how dry the soil should be when plowed. Extremes should be avoided. Plowing when the land is very dry means poor plowing, but it does the land no permanent harm. To plow land when it is too wet may injure the soil for several years, especially if it contains much clay.

**A good seed bed.** — A seed must have moisture in order to germinate, and the best seed bed is one compact enough to permit the capillary moisture to move toward the seed, and yet loose enough to permit air also to come in contact with the seed. Roots, as well as seeds, require enough compactness of soil for the easy movement of capillary water toward the thirsty root hairs, and likewise sufficient looseness

of soil to admit a little air and to allow the roots to grow freely in any direction.

If the soil is in good condition when plowed, the necessary compactness may often be secured merely by allowing several weeks for the rains to make it compact, or to settle it. Sometimes it is necessary to use implements for this purpose, especially the harrow, the plank drag (Fig. 33), or the roller.

*Courtesy of U. S. Department of Agriculture*

FIG. 33. — A PLANK DRAG

Clods are most easily broken when first plowed. Let the harrow, therefore, follow close behind the plow. After plowing or rolling, the harrow should be used immediately so as to leave on the surface a loose layer of dry soil (Fig. 34).

This loose surface layer contains so many large air spaces that the moisture from the compacted layer below can not easily cross these and rise to the surface, where it would be evaporated. Air spaces in the loose surface layer do good by imprisoning the moisture in the lower layers.

The largest crops are usually made on those soils where the roots of cultivated plants grow deepest. This shows

FIG. 34. — HARROWING WHILE THE GROUND IS STILL MOIST

that it is best to plow deep unless there are reasons for not doing so. If land is plowed two or three inches deeper than it has ever been plowed before, there is danger that the first crop after such deep plowing may be injured by the

subsoil which is brought to the surface. This subsoil often dries and forms a hard crust that interferes with plant growth. Moreover, the plant food in this layer of subsoil may not be in such a form that the plant may immediately use it. But the longer it lies on the surface exposed to the air, the more fertile it becomes. Generally, deep plowing is beneficial to the second and the third crops, even if it is not helpful to the first.

**Subsoil plowing.** — The depth of plowing may be increased without any danger of injuring the first crop if each year the plowing is about one inch deeper than the year before. The depth of the plowed soil may be suddenly increased by the use of a subsoil plow, which merely loosens the subsoil but does not bring it to the surface. In using a subsoil plow we must make sure that the lower layers of soil are dry enough to be pulverized. Subsoiling is usually best done in the fall, because at this time the subsoil is likely to be dry and capable of crumbling. Harm only comes from plowing the subsoil when it is very damp.

**When to cultivate.** — Most cultivation consists in destroying the plants not needed and in forming a shallow layer of loose soil at the surface of the ground. Cultivation is often required when there are no weeds. We may be sure that it is needed whenever a surface crust forms on the land, as after a rain.

By breaking this crust and the adjacent parts of the soil with a cultivating implement, a layer of loose soil is formed that contains many large air spaces. Across these air spaces moisture can not move but must remain in the lower layers near the roots. A crust must not be allowed to form; cultivation will prevent it.

### Practice Work and Questions

1. In a shallow can or can top, pour a little ink. In it stand on its larger end a piece of white chalk, or crayon. Observe the gradual rise of the colored liquid as it creeps upward from grain to grain within the crayon. This is capillary moisture and it is moving "uphill."

2. Break a stick of chalk into two pieces. Hold these carefully together. In the ink, as before, stand this mended crayon, and at the same moment stand in it also an unbroken crayon, as in Exercise 1. Do the air spaces between the pieces of broken crayon delay the rise of the colored liquid? Does this explain how cultivation checks the movement of moisture towards the surface?

3. Does a seed more quickly get the water needed for sprouting if the moist soil grains are packed closely against it or if the soil is very loose with air spaces near the seed?

4. Find out whether weeds that have just come up can be uprooted by merely breaking the crust through which they are growing. Test this by cultivating only with a rake a spot in field or garden where there is a slight crust and very young weeds.

5. With a hoe or cultivator throw enough soil on small weeds to cover them completely. Leave the tops of other weeds barely showing through the layer of added soil. A week or more later report to the class what effects these two treatments had on the weeds.

6. In your notebook write a list of at least three horse-drawn cultivating implements. Which of these does best work in cutting off or lifting out weeds that are more than a few inches high?

## CHAPTER XII

## TERRACING AND DRAINING

After a heavy rainfall the water in the ditches and the furrows is muddy. This mud is soil — the best kind of soil — that the currents of water have washed away. The heavy rains not only bear away the fine particles of soil; but in low places where much water collects and where the little currents are strong, grains of sand and fine gravel are torn loose and hurried along. The removal of the soil leaves a wash or scar in the field. Every rain repeats the process, so that in time a gully or ditch deep enough to hide a horse and rider is formed. Soon the water in each row that crosses this wash cuts a little channel down to the main gully and, in time, the field becomes unfit for cultivation (Fig. 35). If the first break is mended, the field will continue to produce good crops instead of becoming worthless. The old saying that "a stitch in time saves nine" is very true in preventing the washing away of the soil.

**Terracing.** — Most hillsides in this climate tend to wash if cultivated. Terracing is a system of protecting hillsides against washing. A terrace is a low bank, or ridge, winding around a hill or slope, but maintaining a perfect level or a uniform grade. The terrace often has to wind about with many an inconvenient curve and crook.

When the top of a terrace is kept even and level, it reduces the amount of washing. The level top line permits the water

to run over the top of the terrace bank along its entire length in the form of a very thin sheet. Water moving in a very thin sheet meets with so much friction from the ground that it has to move slowly and, therefore, can not exert much force to tear away particles of soil.

A terrace on sandy porous soil will hold back all the water that falls except during and after very heavy rains.

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 35. — FIELD ERODED BY HEAVY RAINFALL
Organic matter and grass sod will help correct this condition.

**How a terrace is made.** — By means of either a terracing level or a homemade terracing triangle (Fig. 36), a curving line is marked out near the top of the hillside by placing stakes at intervals of about ten steps. This line may be level or may have a slight grade. In the same way stake the next terrace line at a vertical distance of three feet

lower down the hill on gentle slopes, or five feet lower on very steep slopes. Repeat the operation until all the terraces are staked out. Now mark each line of stakes by means of a furrow, trying to make the curves as slight and gradual as possible. Below this furrow leave a strip of hard unbroken ground about two feet wide. On this throw furrows from above and below. Complete this bank with shovel, hoe or grader.

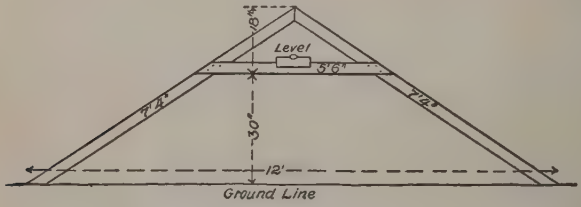



FIG. 36. — A HOMEMADE LEVEL FOR LOCATING TERRACE LINES

**The broad terrace.** — Narrow terraces are very much better than no terraces at all, but they interfere with the use of machinery and may be broken by heavy rains. They are usually uncultivated and so grow up in weeds and briers.

All of these disadvantages are overcome by making the terraces broad enough to be cultivated easily. A broad terrace should be wide enough for several rows of plants to be grown on it. It should usually have a slight slope. By the use of broad terraces many farmers have been able to use binders, tractors, and other kinds of labor-saving machinery that they could not employ on rolling land having narrow terraces or none.

Broad terraces are started just as are narrow terraces. Each time the field is plowed the soil is thrown toward the center of the broad terrace.

**Terraces not always needed.** — Terraces are needed only in hilly regions as a means of preventing washing. In Virginia and Tennessee and northward they are seldom used, partly because wheat or oats, pasture or hay plants, alternate with hoed crops and the fields are not cultivated so continuously as in the Cotton Belt. Farmers in the Gulf States who follow a similar method of farming and who

FIG. 37. — BROAD TERRACES TO PREVENT WASHING

plow deeply can often do without terraces so long as no washes appear in the fields. Very steep hillsides wash less if covered with pasture grasses or with trees.

**What lands need drainage.** — Drainage is needed on fields where water stands in ponds for a long time after a rain; where water oozes to the surface, making seepy spots; and on land where swamp plants grow freely or where water stands in a post hole, within several feet of the surface,

during the growing season. Fortunately the greater part of the hill lands of the Gulf and South Atlantic States need little or no artificial drainage except that intended to prevent washing. On bottom land and on some very stiff or seepy upland fields, however, drainage is usually needed.

**Drainage makes roots go deeper into the soil.** — While the purpose of terracing is to cause porous soils to absorb most of the water that falls on them in order to prevent washing, the object of drainage is to remove the excess water from soils that otherwise would hold too much water.

Strange as it may seem at first, plants are better able to endure a drought on drained than on undrained land. This is because the roots go only as deep into the soil as the air penetrates freely. Drainage opens channels for the air to penetrate farther, and in drained soils, therefore, roots are deeper than in soil that has ordinarily been saturated. When the upper soil dries, the shallow-rooted plants in undrained lands are no longer able to obtain moisture; but the deep-rooted plants in drained soil, being nearer the ever moist subsoil, are uninjured.

**Other benefits from drainage.** — Drainage makes soils more crumbly and less inclined to be cloddy. It increases in the soil the number of helpful *germs*, or tiny living plants, that change vegetable matter into available plant food. This is does by supplying an abundance of air, without which they can not live. Moreover, drainage makes the land ready for plowing earlier. Plants start to grow earlier on drained than on wet soil, for drainage warms the soil by drawing off a part of the water that would otherwise evaporate and which, in evaporating, would cool the soil.

**Two classes of drains.** — The usual drain is an open ditch. Another kind is the covered drain or *underdrain*. A field

in which there are underdrains shows no sign of them for they are two to four feet below the surface and completely covered over. One of their advantages over open ditches is that crops may be grown above the drains.

**Underdrains.** — Tiles, which are hollow tubes of burnt clay one foot long, laid end to end, usually form these drains. The water runs into them at the joints, which do not fit together tightly, and trickles in through the porous walls (Figs. 38, 39). Sometimes underdrains are made of four

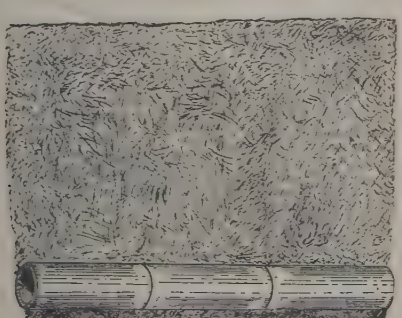


FIG. 38. — DRAINTILES IN POSITION UNDERGROUND

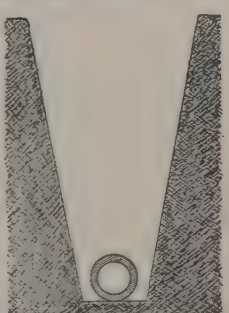


FIG. 39. — END VIEW OF DRAINTILE BEFORE THE DITCH IS FILLED

narrow planks nailed together like a long box, with numerous holes for water to enter. In other cases they are made of three large poles. Although underdrains are several feet in the ground, water flows down to them, thus deepening and airing the soil. They usually drain the soil more completely and to greater depth than do ordinary open ditches.

**Open ditches.** — According to their use, the principal kinds of open ditches are:

1. Canals, or very large ditches

2. Deep drainage ditches
3. Hillside ditches (usually shallow ditches)

The water in open ditches often carries much mud and other fine material. When the current is rapid, this soil material is carried onward by the water and is not deposited. If any part of the ditch is less steep than the portion above it, the water must necessarily travel more slowly. A sand bar usually forms where the current is thus checked, for the slower current is unable to carry its burden of fine sand and other soil particles. These are thrown down and fill the ditch, making work for the farmer in opening it again. The banks of a deep open ditch should not be upright or nearly upright, for they invariably cave in and the earth fills the ditch.

It is a good rule to have a uniform grade for a ditch, steep enough to carry off the water without filling the ditch with soil and yet not so steep that the current will cut deep into the bottom of it. This grade varies with the dimensions of the ditch, as you will learn from books on drainage. For small ditches there is usually from three to five inches of fall in every one hundred feet.

### Practice Work and Questions

1. Walk over a field and notice the little washes just beginning. Think of a way by which each one could be stopped.

2. When a ditch or river makes a sand bar at a curve, is the sand bar on the inner or on the outer side of curve? Why? Watch a winding brook as it flows and learn why a ditch or river tends to become more and more crooked.

3. Look at one of the ditches on a farm that you know and plan how it could be improved. Is it as straight as it might be? Do roots of bushes grow across it? Or does anything else catch drifting litter and cause the ditch to fill?

## CHAPTER XIII

## HOW THE SOIL BECOMES POOR

Most soils were productive when first cultivated. Why have so many acres become poor and unprofitable?

**Surface washing.** — One of the means by which land becomes poor and one that can be prevented by proper use of ditches and terraces and by better methods of farming is surface washing. If any fields are so steep that terraces or ditches will not protect them sufficiently, they should be allowed to grow up in useful trees, or they should be planted to some grass or grazing plant, the matted roots of which will help to hold the soil in place.

**Leaching.** — On all soils there is a loss of fertility that can not be seen and is often not suspected. This is *leaching*, or the dissolving of plant food by the rain water and the draining of this water and of the dissolved plant food in it through the soil and into the streams. This loss in our Southern climate is greater than any other. It occurs chiefly during the winter, when rains are heaviest and when there are no living roots to use the soluble plant food. It can be prevented by causing living plants to occupy the fields during the winter. Wheat, rye, crimson clover, or any other plants in active growth during the winter send their roots throughout the soil. These roots absorb the soluble plant food, leaving very little that can be dissolved by the rain water as it drains through the soil. Even weeds that keep green during the winter do good in this way.

**Loss of vegetable matter.** — Another cause responsible for much of the poor soil in the South is the loss of vegetable matter. This occurs whenever the farmer grows corn,

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 40. — SOY BEANS PLOWED UNDER OR FED TO STOCK AND THE MANURE RETURNED ADDS LARGE QUANTITIES OF HUMUS TO THE SOIL

cotton, or any other crop that is kept thoroughly cultivated and does not leave on the land a large amount of roots, leaves, or stems. Fire is one of the farmer's worst enemies, for it destroys vegetable matter needed to improve the soil.

When the vegetable matter of the soil disappears, the soil becomes lighter in color, drier in dry weather, more cloddy, and harder to work. Clay soils then become too compact for roots to thrive in them. In dry weather the crop on such land is parched and stunted or ruined, while on similar land, well supplied with rotted vegetable matter, the crop is better able to withstand drought. This is true, largely because rotted vegetable matter is somewhat like a sponge in having the power to hold moisture. When the roots come in contact with this decayed vegetable matter, they absorb moisture and use part of its substance for food.

The farmer may replace the vegetable matter that disappears when clean cultivated crops are continually grown by producing an occasional crop that leaves large amounts of roots or foliage and stems on the ground. Some of the crops that thus increase the supply of vegetable matter are the clovers, velvet beans, and kindred plants, and the grasses that form a sod or dense covering over the entire surface. *The surest and cheapest way for the farmer to enrich his land and to make larger profits in farming is constantly to add vegetable matter.*

**Sale of plant food in crops.** If a farmer every year hauls crops of grain or hay or potatoes from his field without putting anything back, there will come a time when he will say that the field is too poor to cultivate. Crops differ greatly in the kind and amount of plant food they remove from the soil. The lint of cotton and the sugar of sugar cane consist almost entirely of materials drawn from the air, and so these products remove almost no plant food. Yet cotton may make the soil poorer because its clean cultivation causes the loss of vegetable matter; because its seed removes considerable plant food; and most of all, because

it leaves the land without living roots during the winter and thus permits the rain to leach and to rob the soil. Sugar cane may be an exhausting crop because the stalks that are carried from the field contain much plant food and because the leaves are usually burned. This does not mean that exhausting crops should not be grown, but that something must be returned to the land in exchange for what is removed.

**Lack of drainage makes soils unproductive.** — All the causes of soil impoverishment mentioned are due to substances taken from the soil. They have all been forms of subtraction. There is, however, an addition to the soil that may make it poor. Too much water injures the soil and the crop if it is not drained away either by the porous nature of the soil or by ditches cut by the farmer. This subject was discussed in the last chapter.

### Practice Work and Questions

1. Note that plants are smaller on *galled* spots, from which soil has been partly washed away. Were the rows any steeper on these spots than elsewhere?

2. Have any of you seen an ash hopper, the leached water from which is evaporated to make lye?

Leach out the potash from wood ashes that have never been wet by slowly dripping water on the ashes held in a funnel or funnel-shaped piece of tin, lined inside with cloth. Evaporate some of the dripped water in a shallow pan kept on the stove to see that it leaves solid matter which the water leached from the ashes. Describe this test in your notebook.

3. Does the soil from a galled spot show as much dark material or vegetable matter as the soil from the richest part of the field? Why does a good farmer cover galled spots with cornstalks and other litter? Note the difference in the size of plants on newly cleared land and on old land near by that has not been fertilized.

4. **Sale of plant food.** — Turn to Fig. 81 and from it learn that in selling cotton lint almost no plant food is lost but that the seed takes away much plant food.

## CHAPTER XIV

## HOW LEGUMINOUS PLANTS ENRICH THE SOIL

Most lands produced much better crops in the first few years after the trees were removed than after many years of cultivation. Let us consider what makes newly cleared land especially productive.

**Vegetable matter makes rich land.** — In a forest, year after year, the trees drop their leaves; the decayed leaves and roots make the soil very loose and rich. When the trees are removed, the *new ground* produces good crops that secure food from the vegetable matter. The crops are good on new ground also because the humus in dry weather holds moisture like a sponge. Drought, therefore, is not much felt by crops on land containing much humus. When plowed, the dark loose soil crumbles readily, for the reason that vegetable matter in the soil keeps the particles of clay from sticking together and from turning up in great useless clods. The skillful farmer can renew his land or make it just as fertile as it was when first cleared, if he will add to it enough vegetable matter of the right kind.

**"Resting" land not the quickest way to enrich it.** — Farmers have learned that even a crop of weeds adds vegetable matter, and so they sometimes leave certain poor fields uncultivated for a year or two to "rest," or improve. Such improvement of the land is slow. The soil grows rich much more rapidly when the farmer sows the seed of soil-

improving plants. The soil does not need rest but it does require change of crops.

**Making land fertile by growing certain plants.** — Different plants are very unlike in the value of the vegetable matter they add to the soil. Those that make the best fertilizer are rich in nitrogen. Corn, sorghum, and similar

FIG. 41. — LEAVES OF LEGUMINOUS PLANTS

1, hairy vetch; 2, velvet bean; 3, peanut; 4, alsike clover; 5, alfalfa; 6, field pea; 7, sweet clover; 8, bur clover; 9, red clover; 10, crimson clover.

crops grow much larger in fields where vetch was grown the year before. Twice as large a crop of oats, wheat, or hay has been produced where velvet beans or clovers had been grown the year before as where there had been no soil-improving crop.

**How to know plants that improve the soil.** — The plants that are most valuable for plowing under to enrich the land are closely akin. The clovers, cowpeas, velvet beans, vetches, and similar plants belong to the bean family (Fig. 41), which consists of the *legumes* or *leguminous* plants. All the legumes the farmer makes use of have flowers shaped like the garden pea, sweet pea, and cowpea (Fig. 42). The flower of each consists of (1) a broad petal standing up somewhat like the wings of a butterfly at rest, (2) a folded portion that reminds us of the butterfly's body, and (3) a petal standing up straight and alone on each side of the folded part.

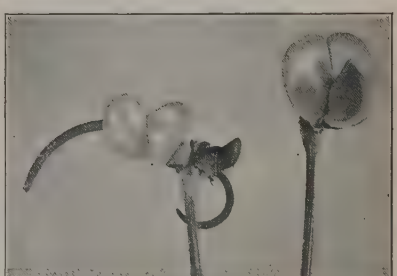


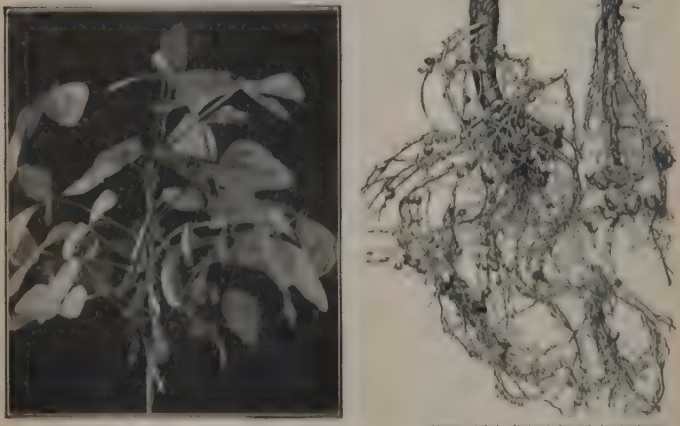
FIG. 42. — COWPEA FLOWERS AND YOUNG PODS

FIG. 43.—PODS OF A LEGUMINOUS PLANT

You will quickly see that garden peas, cowpeas, sweet peas, locust trees, and some weeds have blossoms of this shape. The clovers bear their flowers in heads, more like the shape of the end of the finger. Each clover head is not a single flower, however, but a mass of dozens of tiny ones. Each of the little flowers has the same general shape as the pea blossom. Plants on which the flowers are of this "butterfly" shape are called legumes and are known to make the soil richer. The seeds of these plants are

borne in pods. (See Fig. 43.) Their leaves are compound, that is, made up of several smaller parts called leaflets. (See Fig. 41.)

**Tubercles or nodules on the roots of legumes.** — Carefully dig up cowpea, clover, and other legumes without stripping off the smaller roots. Do you find little round or pear-shaped knots attached to the roots? This is an indi-



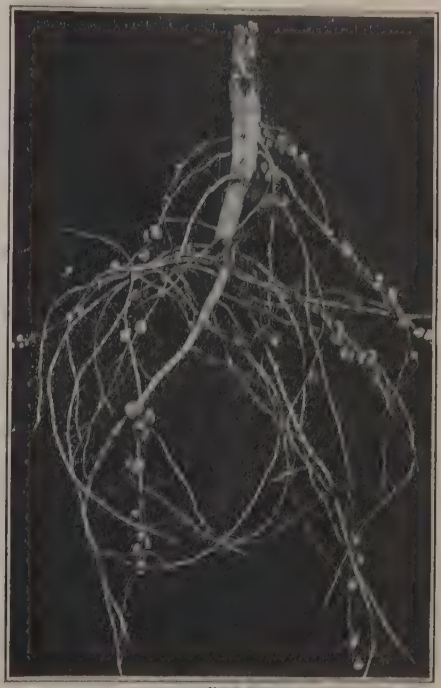
*From Gehr's Principles of Agriculture*

FIG. 44. — THE TOP AND ROOTS OF SOY BEAN SHOWING PODS AND NODULES

cation that the plants are legumes and that they are at work making the soil rich. These knots are root *tubercles* or *nodules* (Figs. 44, 45).

Each tubercle is a fertilizer factory in which the nitrogen of the air is changed into food for plants. In the next chapter we shall learn more about how this change is brought about.

**What the cowpea or clover plant does with nitrogen.** — Let us consider what becomes of the nitrogen that a tubercle sends up in the sap current to the clover plant or other legume on which it is growing. A part of this rich food is deposited in the roots, another in the stem, another portion goes to make the leaves, and still another helps to make the seeds. When leguminous plants are plowed into the soil, they enrich it both in nitrogen and vegetable matter.



*From Sampson's Effective Farming*

FIG. 45. — COWPEA ROOT SHOWING TUBERCLES

Even if the farmer mows and hauls away the vines for hay, there is still left in the ground the nitrogen that was stored in the roots and lower part of the stem and in the fallen leaves. The enrichment is much greater if the tops of the soil-improving plants, as well as the roots, are plowed into the soil.

**Using legumes for both feed and fertilizer.** — The plants that most enrich the soil make the richest hay and pasturage for horses, cattle, sheep, hogs, and poultry. The farmer often asks, "Does it pay better to use the vines or tops of cowpeas or clover as food for live stock or to plow them into the ground as fertilizer?" The best answer is that letting these crops pass through an animal does not greatly lessen their value as fertilizer. The starch, sugar, and fat that the animal takes out of its food have no value as fertilizer. Enough live stock ought to be kept on all farms to consume the legumes that are grown. The farmer can then make a double use of the leguminous crops; he can use them as stock food, and later for fertilizer.

FIG. 46. — ROOTS OF HAIRY VETCH SHOWING NODULES

The little fertilizer factories on the roots of leguminous plants are worth more to mankind than all the gold in the world. Nearly every farm that to-day is too poor to keep

the farmer's family in comfort can be made fertile by the wise use of velvet beans, cowpeas, crimson clover, and related legumes.

### Practice Work and Questions

1. Bring to school for showing in class the blooms, pods, and leaves of as many soil-improving plants as you can find.

2. Learn the name, if you can, of every leguminous plant that is brought to class.

3. In your notebook make drawing showing the shape of leaves of two leguminous plants; remember that a leaf of most kinds of legumes consists of several separate leaflets.

4. **Home project.** Pupils who intend to raise a pig or a calf or poultry should ask their parents when to plant some leguminous plant for the pets to graze, such as bur clover, white clover, red clover, vetch, alfalfa, soy beans, or peanuts. Then you will wish to read in Chapter XXVII the paragraph about the pasture plant that you select. You should also write to the agricultural college of your state for free pamphlets on the same subject.

## CHAPTER XV

## BARNYARD MANURE

A farm with many animals is usually rich and productive because of the supply of manure. Experiences in all countries show that this material is an excellent means for enriching all kinds of soil. Some chemical fertilizers, however, are beneficial only on certain soils.

Manure has these good effects: (1) It makes the earth loose and mellow, allowing the roots and air to come into contact with all parts of the soil. (2) After it has rotted, it enables the soil to hold moisture in dry weather. (3) It furnishes plant food to the roots of growing crops. (4) It adds needed germs and causes the beneficial ones already in the soil to thrive and multiply, thus helping the crop.

**Richest manure from richest food.** — Barnyard manure is composed largely of ground-up parts of plants and contains very nearly what the plants contained. The richest is made by feeding cottonseed meal and other foods rich in nitrogen. Hay from cowpeas and other legumes makes better manure than that from shucks, straw, or grass.

**Fertilizing crops by buying food for live stock.** — A farmer may buy 100 pounds of cottonseed meal and place it in the ground as fertilizer. It would pay him better first to feed it to cattle and then to use the manure. If all of this, solid and liquid, were carefully saved, it would have the same value as a fertilizer as 80 pounds of cottonseed meal. Animals take from their food chiefly those sub-

stances that are worthless as fertilizers, such as starch and fat. The farmer, therefore, who buys cottonseed meal to use as a fertilizer for his crop can make two profits by first feeding it and then using the manure as fertilizer. Any pasture may be made rich by keeping on it live stock that is fed on plants grown on other parts of the farm.

**Manure varies in value.** The manure from different animals varies in fertilizing value largely because the animals

FIG. 47. — MANURE PILED WHERE ITS PLANT FOOD WILL BE LEACHED

are fed on different foods. Manure from the poultry house is several times more valuable than any other.

When only the solid waste from animals is saved, the farmer secures only about half the fertilizer available. If the manure pile has no roof over it, the rain water destroys much of the fertilizing value. Manure that has been exposed to rain for a number of months is sometimes worth less than half as much for fertilizing crops as it was at first. Most of

the plant food has been dissolved and carried off by water; some of the nitrogen has changed into ammonia and passed off into the air as a strong-smelling gas; and a large part of the soil-loosening materia' has disappeared by being slowly "burned," for rotting is a kind of slow burning. A roof over the manure pile prevents the great loss caused by water (see Fig. 47), but the other losses go on even under a roof. The best plan, therefore, is to plow manure into the ground as soon as possible so that the soil will absorb the ammonia that might otherwise be lost.

**Composts.** — Compost heaps are piles of manure mixed with other materials, such as leaves or cottonseed, with the addition sometimes of phosphates. Partial rotting renders the manure less coarse and makes it act more quickly on the crop. The same materials may be mixed in the furrow in the field. When they rot there, the soil prevents loss.

**Value of manure.** — Barnyard manure is dilute. The farmer must get it to the field with as little labor as possible, for fully three fourths of its weight is water that has no value. Large amounts must be used on an acre. In a ton of manure there are only about 25 to 35 pounds of the three valuable forms of plant food (nitrogen, phosphoric acid, and potash), or about as much as in 200 pounds of a high-grade complete commercial fertilizer. A ton of manure contains about a quarter of a ton of organic matter and billions of helpful germs. These can not be bought in commercial fertilizers.

### Practice Work and Questions

Ask your parents to tell you how many loads of manure ought to be used on a garden acre; on an acre of corn; also how many additional bushels of corn should be made the first year as the result of such manuring.

How are you going to manure your plot of land?

## CHAPTER XVI

## COMMERCIAL FERTILIZERS

Soils have abundance of all necessary plant-food materials except nitrogen, phosphates, potash, and lime, any of which may be deficient in some lands. When one or more of these valuable forms of plant food is lacking, poor crops result unless something containing the element wanted is added.

The lack of even a single one of these necessary substances, or forms of plant food, will cause the crop to be about as poor as if all four of them were deficient. (See Fig. 48.) It is important to find out which of these is wanting, and to use on each field a fertilizer that contains just the kind of plant food needed in that soil. Plants, if denied nitrogen or phosphates but given an abundance of everything else needed, would die.

FIG. 48. — GRASS HAY FROM EQUAL AREAS

On left, unfertilized; on right, fertilized with nitrogen and potash.

**Nitrogen and ammonia.** — Commercial fertilizers (so named from the word *commerce*, meaning *trade*) are those prepared and furnished by merchants or manufacturers. When they contain only nitrogen, they are called nitrogenous fertilizers. The most important commercial fertilizers that

are rich in nitrogen are cottonseed meal and nitrate of soda. If nitrogen occurs in mixtures with other precious plant foods, the fertilizer may be called an *ammoniated fertilizer*, or "guano." Ammonia is a combination of fourteen parts by weight of nitrogen with three parts of hydrogen (Fig. 49). Fourteen pounds of nitrogen, the most precious of plant foods, may become seventeen pounds of ammonia. Hence, if there is printed on a bag of fertilizer the statement that it contains 2 per cent nitrogen, you can calculate how much ammonia this equals by multiplying the amount of nitrogen by 17 and dividing the product by 14. On the other hand if the printing on the bag shows that cottonseed meal contains 7 per cent ammonia, you may change this to nitrogen by dividing by 17 and multiplying by 14. The amount of ammonia is always larger, because it contains all the nitrogen and another element besides.

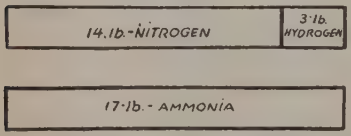



FIG. 49. — DIAGRAM SHOWING WEIGHT OF AMMONIA EQUAL TO 14 POUNDS OF NITROGEN

**Cottonseed meal.** — This excellent fertilizer is a yellowish, powdery material made from the kernels of cottonseed after removing most of the oil and hulls. Cottonseed meal is about twice as rich in nitrogen as the whole cottonseed from which it is made.

Cottonseed meal usually contains between 5 and 7 pounds of nitrogen in each 100 pounds of meal and is, therefore, expensive. It also contains some phosphate and potash. There are several grades of this meal, those that contain the largest proportion of hulls being the least valuable. This meal can not be used by plants until it has decayed.

It is more suitable, therefore, for crops that occupy the land in the warm season than for very early plants which make their growth in cool weather.

**Nitrate of soda.** — This fertilizer has more than twice as much nitrogen as cottonseed meal. It costs more than twice as much a ton but does not need to be used in such large quantities. It is brought by ships from South America,

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 50. — EFFECT OF NITRATE OF SODA ON TIMOTHY

This fertilizer was applied at the rate of 200 pounds an acre. The treated portion (on left) yielded 1630 pounds of field-cured hay an acre; the unfertilized portion (on right) yielded 540 pounds an acre.

for in that hot country the nitrogen has already been changed into a form of nitrate that is ready to be used by plants at once. Read about Chile in a geography or encyclopedia to learn how nitrate is obtained.

When nitrate of soda is sown broadcast on the surface of the ground where young wheat or oat plants are growing, the

moisture of the soil dissolves the fertilizer and carries it downward to the roots of plants. Within a week after this fertilizer is sown, wheat and oats becomes much greener and more luxuriant. It is especially suitable for plants that make their growth during the cool months, such as wheat, oats,

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 51. — FIELD OF WHEAT WHICH YIELDED 30 BUSHELS TO THE ACRE
The preceding crop, corn, received a heavy application of stable manure. The wheat was fertilized with 500 pounds of acid phosphate to the acre.

and the like, and for vegetables, like lettuces and radishes, in which quick growth is desired. It is also suitable for many other crops (Fig. 50).

**Kinds of phosphates.** — Phosphates are those fertilizers that contain the element phosphorus, in the form of phos-

phoric acid. There are three kinds of phosphates and they are of very different values. The first is called natural, or *raw phosphate;* sometimes it is called Tennessee phosphate, Florida phosphate, or *floats*. It is simply the phosphate rock just as it is dug or brought up by dredges from its place in phosphate beds, except that it has been ground into a very fine powder.

Although raw or crude phosphate can not be dissolved in pure water and can not be used immediately by the roots, nevertheless it has some value as fertilizer for some soils and crops. When raw phosphate is kept for some time in contact with decaying vegetable matter or mixed with manure, a part of its phosphate changes into a form which roots can use.

**Acid phosphate.** — This fertilizer is so called because it is made by adding sulphuric acid to the raw or natural phosphate. This acid so changes the phosphate that roots can immediately absorb it. This phosphate is soluble. There is a third or intermediate form of phosphate that plants can use. This and the soluble phosphate are added together and called the *available* phosphoric acid, that is, the kind that plants can use promptly.

**Basic phosphate.** — This form is made from waste material in some of the steel mills. Most of its phosphoric acid is available to roots.

**Fertilizers containing potash.** — The commonest of these is *kainite*. It is dug from deep mines in Germany and France. It contains about 12 per cent of potash. Muriate of potash is obtained from the same source. About half its weight, or 50 per cent, is potash. Kainite and muriate of potash are nearly white, somewhat resembling coarse table salt.

**Mixed fertilizers.** — Many fertilizers are composed of two or more kinds mixed together, for example, cottonseed meal and acid phosphate. Such a fertilizer would contain both nitrogen and phosphoric acid. If a fertilizer contains all three of the plant foods, nitrogen, phosphoric acid, and potash, it is known as a *complete fertilizer*. If the tag on a bag of fertilizer reads 10-2-2, this usually means that the mixture contains 10 per cent available phosphoric acid, 2 per cent ammonia (equal to 1.65 per cent nitrogen), and 2 per cent potash.

**Commercial value of a fertilizer.** — The commercial value of a pound of nitrogen is the average wholesale selling price of this substance in the largest fertilizer markets. You may learn from your Commissioner of Agriculture at the State Capitol, the latest commercial values of nitrogen, phosphoric acid, and potash. The commercial value of a ton of any fertilizer will be the sum of the commercial values of the nitrogen, phosphoric acid, and potash contained in one ton of the fertilizer.

**Home-mixed fertilizer.** — Sometimes mixed fertilizers sell at prices too much above their commercial values. In such cases the farmer can usually save several dollars a ton by mixing his own fertilizers, buying only the simple materials, each usually containing one element. A farmer who mixes his own fertilizers is also able to make a different mixture adapted to each crop and to each field.

**Which fertilizer to choose.** — The fertilizer in which one pound of the desired plant food costs least should be chosen. If you wish to purchase a nitrogenous fertilizer, buy that one in which a pound of nitrogen costs least; this will not always be the fertilizer that is sold at the lowest price a ton. Often the cheaper fertilizers have had "filler,"

or worthless material, added to enable the dealer to sell them at a lower price.

**Special effects of fertilizers.** In some soils there are small amounts of substances hurtful to plants, called *soil toxins*, that is, soil poisons. Their poisonous effects on plants are overcome by acid phosphate and some other fertilizers. They are also remedied by good cultivation, rotation, and other steps in good farming.

### Practice Work and Questions

1. Try to get samples of as many as possible of the fertilizers mentioned above to be shown in class. In your notebook describe each one. Be ready to report the effects of any fertilizer tests you may know about.

2. Fill two tomato cans with the same poor soil, and in them plant seeds of corn or radish. Water both cans alike until seedlings have come up. Then water one can with pure water and the other with a nitrate solution made by dissolving one teaspoonful of nitrate of soda in one gallon of water. Continue this for several weeks. Which plants grow faster? Which have the greener color?

3. **Home project.** Write in your notebook for reading to the class the kinds of fertilizers that you have decided on, with your parents' help, for your field patch or garden plot.

Probably your parents will furnish you with small amounts of one or more of the fertilizers mentioned in this chapter for you to test on separate rows in the garden or field.

Some parent may furnish the school a little of several kinds of fertilizer materials so that the class in agriculture may make a real fertilizer experiment on a field near the school. The next chapter shows how to make such a fertilizer experiment.

## CHAPTER XVII

## SUITING THE FERTILIZER TO CROP AND SOIL

The amount of fertilizer that it pays best to use varies with the land and with the crop. As labor and land become scarcer or higher, it usually pays to increase the amount of fertilizer. (See Figs. 51, 52, 53.)

**Fertilizers most profitable on well-tilled fields.** — Some land may be too poor for very large amounts of fertilizers to be profitable. This is because a poor soil may be so shallow or so deficient in vegetable matter that in dry weather it can hold enough water to make good use of only about 300 pounds of fertilizer to the acre. When this same soil is made deeper and supplied with vegetable matter, it may hold enough moisture to use profitably several times this amount.

**Loss of fertilizer in the soil.** Experienced farmers often apply more phosphate than the crop will receive from the land because the clay or iron in the soil changes some of the phosphate into a form that plants can not utilize. This can not be prevented and fortunately phosphate is not very expensive. Nitrogen, however, is about three times as expensive as phosphoric acid. Some nitrogen may be leached out of the soil. Hence, the wise farmer tries to apply no more than the roots can take in.

**Suiting the fertilizer to the crop.** — Different plants require varying amounts and kinds of fertilizer. Vegetables and cotton usually pay better for large amounts of fertilizer than does corn. For cotton many farmers use only 200 pounds to the acre, although 400 to 600 pounds or more is sometimes applied. Growers of vegetables increase this amount to one ton or more.

Crops growing in cold weather, such as oats, wheat, lettuces, radishes, and Irish potatoes, should receive their supply of nitrogen in a soluble form like nitrate of soda. Crops making most of their growth in hot weather, such as sweet potatoes and cotton, can use either soluble nitrogen or that in cottonseed meal and peanut meal. This is possible because certain helpful germs in the soil needed for rotting these meals are more active in warm than in cold weather.

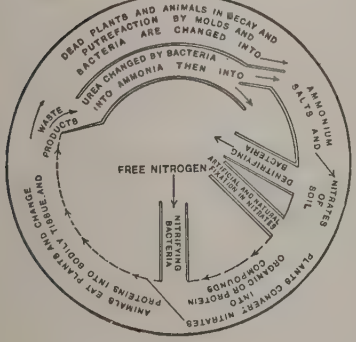

DEAD PLANTS AND ANIMALS IN DECAY AND PUTREFACTION BY MOLDS AND BACTERIA ARE CHANGED INTO
UREA CHANGED BY BACTERIA INTO AMMONIA THEN INTO
AMMONIUM SALTS AND NITRATES FOR SOIL
WASTE PRODUCTS
FREE NITROGEN
DENITRIFYING BACTERIA
NITRIFYING BACTERIA
PLANTS CONVERT NITRATES INTO ORGANIC OR PROTEIN COMPOUNDS
ANIMALS EAT PLANTS AND CHANGE PROTEINS INTO BODILY TISSUE AND

Fig. 52. — The Nitrogen Cycle

The complete cycle of nitrogen from the air through plant and animal life back to the air is here shown. Action of bacteria is indicated by double lines; plant and animal action by broken lines.

Soil-improving plants, such as legumes, do not require nitrogen in the fertilizer, because they are able to get their nitrogen from the air, as you have learned in an earlier chapter.

**Judging the need of a soil for fertilizer.** — What a soil needs can not be told by looking at it. There are, however, some helpful rules. Generally a soil that is black or very

dark contains much vegetable matter, which in turn holds much nitrogen. On the other hand if the stalks of crops cultivated on a field are small, there is probably need of nitrogen in the soil. A crop of cowpeas or clover usually leaves the soil rich in nitrogen. Clay soils generally contain more potash than sandy soils.

FIG. 53. — OATS FROM EQUAL AREAS
On left, fertilized; on right, not fertilized.

**How to find what fertilizer the soil needs.** — Even when a chemist analyzes soil and finds out just what it contains, he can not tell how much of each necessary element is in a condition for plants to use. The chemist's analysis does not, therefore, show what fertilizer to apply.

The only way to determine the kind of fertilizer a soil needs is to make an experiment on that soil with different fertilizers. It will pay to make this experiment with the

principal crop of any farm. The following diagram shows how to make such a test. The areas must be of exactly the same size; for example, one-eighth of an acre. The figures in the table show the number of pounds of fertilizer for one acre:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|
| 200 lb. kainite<br>200 lb. acid phosphate<br>100 lb. nitrate of soda | 200 lb. kainite<br>100 lb. nitrate of soda | No fertilizer | 200 lb. acid phosphate<br>100 lb. nitrate of soda | 200 lb. acid phosphate | 100 lb. nitrate of soda | 200 lb. kainite |

The plots must be on the same kind of soil and equally well drained. If it is not convenient to harvest the crop separately on so many plots, use only plots 1, 2, 3, 4, and 5.

**Fertilizers that do not work well together.** — Two fertilizers that must not be mixed are lime and phosphate. The lime changes the phosphate into a less soluble form and thus reduces its value as a fertilizer. Ashes contain much lime; therefore, ashes and phosphate should not be used together.

### Practice Work and Questions

1. Learn from a farmer in the neighborhood or from the printing on fertilizer sacks the composition of the fertilizer commonly used in your neighborhood. Write this in your notebook. Is it used on all sorts of soils? If it suits poor clay soils, is it likely to be the best for sandy land?

2. Any pupil who will make the fertilizer experiment described in this chapter should be able to increase greatly the future profits on that farm or on similar soils in the neighborhood. Record in your notebook the details of this experiment or of any modification of it that you may make.

## CHAPTER XVIII

## LIME

Chalk is one form of lime. Another is *quicklime*, which consists of large lumps used by bricklayers to make mortar. If a bricklayer pours only a small amount of water on a lump of quicklime the lump absorbs the water and falls into a powder. This powder is *slaked* lime, which is sometimes used as a fertilizer. A more common form of lime for improving the land is *ground limestone*.

**Lime overcomes sourness of soils.** — A sour, or *acid*, condition of the soil is hurtful to most useful plants (Fig. 54). All forms of lime are *alkaline*, that is, the opposite of *acid*. If lime is placed in contact with an acid, a part of its substance unites with the acid and overcomes the acidity. If, therefore, lime is put on sour soil, it removes the acid condition and makes the soil more favorable to plant growth.

**How to know that a soil is sour.** — A doctor can not cure sickness until he determines the nature of the ailment. When he has done this, he knows what medicines to give. Likewise it is important for the farmer to know the condition of his soil. If sourness is the principal trouble, lime will enable some crops to grow much better on this soil. One test for sourness, or acidity, is easily made with strips of blue litmus paper which may be purchased at a drug store. Acid turns the paper pink or red.

With a knife cut a slit in the moist soil to be tested and place the blue paper in this slit. Press the damp soil against both sides of the paper for about two minutes. If the paper becomes pink where it has been moistened by the earth, the soil is acid. The deeper or redder the color, the more acid is the soil.

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 54. — SHOWING EFFECTS OF LIME IN GROWING HAY

Both these plats received the same treatment, except the one on the left was limed and clover predominates; in the unlimed plat the growth is less rank and timothy and redtop predominate

**Large areas of acid soils in the South.** — In regions where the long-leaf or yellow pine is the principal forest tree, much acid soil is usually found, especially in the low places. Farther from the coast sandy soils are sometimes acid even on the tops of mountain plateaus. Spots of poorly drained bottom lands, known as "crawfish land," are often sour. Many other Southern soils are acid.

**Some plants are able to grow in a slightly acid soil.** — Fortunately for the farmer who has acid soil, many useful plants grow fairly well in such land. Some of the crops that can endure slight acidity of the soil are cotton, corn, cowpeas, and watermelons. Therefore it may not pay to buy lime for these. Other plants, however, will not thrive

*Courtesy of Virginia Agricultural Experiment Station*

FIG. 55. — ALSIKE CLOVER

On right, limed; on left, not limed.

on a sour soil until lime is applied. Among these are alfalfa and most of the clovers (Fig. 55). Peanuts, wheat, onions, beets, cabbages, and many other plants yield much better when lime is used on a soil that previously was acid.

One or two tons of ground lime to the acre is the amount

generally used. This need not be applied oftener than once in three or five years.

**Uses of lime when added to the soil.** — (1) Lime is a plant food. (2) It overcomes the acidity of sour soils. (3) It causes the beneficial nitrate-forming germs to increase by decreasing this acidity. (4) It is useful also in hastening the rotting of vegetable matter, such as leaves or weeds, which has been plowed under. This rotting must occur before roots can use vegetable matter. (5) It makes stiff clay soils more porous and more easily worked. (6) Like cultivation, it is a stimulant. (7) It possibly changes some of the potash in the soil into a form that plants can use.

The lime may cause a poor, sandy soil to become exhausted rapidly by putting into crops the little fertility that it contains. Such wearing out of soil can be avoided by constantly adding vegetable matter and the necessary plant food.

Lime should not be added to a manure pile or compost heap. It rots these materials so rapidly that it drives off into the air a part of the nitrogen or ammonia of the manure, the loss of which is made known by the strong smell of the escaping ammonia gas. A covering of soil over the compost pile absorbs and holds the ammonia; hence, lime in the soil does not cause a loss of ammonia.

One should avoid mixing lime with acid phosphate.

### Practice Work and Questions

1. If possible, get and weigh a lump of builders' lime. Let water drip slowly on it. Again notice its size. The resulting powder is slaked lime.

2. Would the father of anyone in this class like to have his soil tested for sourness? If so, a few strips of blue litmus paper may be bought at a drug store for only a few cents, and the pupils may make the

test. Keep the litmus paper tightly closed in a bottle or wrapped in oil paper, and, in using it, avoid getting on it perspiration from the fingers, for perspiration is acid and turns the paper pink.

There are more accurate but more difficult tests for acidity. These you may learn to make when you are in high school or college.

3. Ask your parents what farmers, if any, have used lime within the past year or two and on what crops. Did it increase the crop or change the proportion of weeds, grasses, or clovers?

Possibly the teacher will let the class make an excursion to some field that has been limed. By means of the blue litmus paper test you will be able to learn whether the adjacent unlimed soil is acid and whether enough lime was used to overcome soil acidity completely.

4. **Home project.** Test the soil at home where you are growing some crop. Then discuss with your parents the question whether you should apply lime or some substitute, such as unleached *wood* ashes.

## CHAPTER XIX

## CORN

More corn to the acre is now produced in the South than formerly. Boys have had a large part in bringing this to pass. As members of corn clubs, boys have often been the first to introduce into their communities improved methods of seed selection, preparation, cultivation, and fertilization. Their yields of corn have usually been the highest in the county (Fig. 56) and their methods have later been adopted by many of their neighbors. The help of every farm boy is still needed in lifting yet higher the average yield of corn in the South.

Many a boy has made his "club acre" of corn yield net profit enough to pay a part of the expense of his later education. Would you like to follow the example of these active and ambitious boys? The boys' agricultural club offers the opportunity. If there is not already one in your school, ask your teacher to invite the aid of the county farm demonstration agent or club leader in forming one.

**The relatives of corn.** — Corn belongs to the *grass family*. It is related to all the true grasses, including sugar cane, wheat, oats, rye, barley, rice, and all the grasses of pastures and hayfields. Corn differs from most of its relatives in having both a tassel and an ear and in their being located on different parts of the plant.

A corn plant in full tassel gives off a cloud of dustlike

particles when shaken. There are estimated to be about 18,000,000 tiny pollen grains formed by each tassel. Most of these are wasted, but those that fall on the silks become the parents of grains of corn.

**Races of corn.** — There are only a few races of corn, the

Fig. 56. — An Alabama Club Boy's Prize Acre of Corn

most important being pop, sweet, dent (or common), and flint corn. In each race there are many varieties.

**Mixing of races of corn.** — Some ears of pop corn have some kernels like those of field corn. These have been crossed with common corn. Hence pop corn should not be planted near other kinds that will tassel at the same time. If it is impossible to plant it away from all other kinds, arrange the date of planting so as to have it silk

and tassel before the other corn, or after the tassels on the common corn have shed their pollen and have dried. Sweet corn readily crosses with field corn, and some of its grains are then smooth instead of wrinkled, as dry kernels of sweet corn ought to be. When these *races* cross, the character of the grain is usually changed the same year that the mixing occurs.

**Varieties of field or dent corn.** — There are several hundred varieties of field corn. Many of them are Northern kinds, too small and early to yield well in the South. In most experiments in the South varieties with two medium-sized ears have yielded more corn than those having a single large ear to a plant.

**Mixing may not show the first year.** — There may be a large amount of crossing between varieties of common corn, and yet the farmer may be unable to see it by examining the ears. A white variety may grow beside a yellow dent corn and yet the first year there may be no white grains on the yellow ears. This is because crossing between two *varieties* of dent corn does not always change the character of the grains the first year. The growing of two varieties of corn close together (unless they are planted at such dates as to cause them to tassel at different times) should be avoided.

Corn is improved easily by the method given in Chapter VIII. It also quickly becomes mixed and hence inferior if great care is not taken in the selection of seed. Learn the best kind of corn for your soil, then keep it pure and improve it.

**Corn roots and the preparation they require.** — A corn plant may have twenty to fifty roots, many of them as long as the plant itself. These, with their branches and root hairs, are always busy taking water from the soil. Hence corn yields best on a soil that is always moist (but not

wet). It needs land so deeply plowed before planting and so well drained that some of its roots can grow deep down where there is moisture even when the weather is dry. Plow deeply in preparing a field, if you can plow early.

**Planting.** — Corn is planted in elevated ridges or beds, in depressions or water furrows, or in level ground (Fig. 57), according to the soil and the farmer's judgment. Plant corn just deep enough to make sure that it will continually be in moist soil until germinated. Usually a depth between one and three inches is best. (See Fig. 10.)

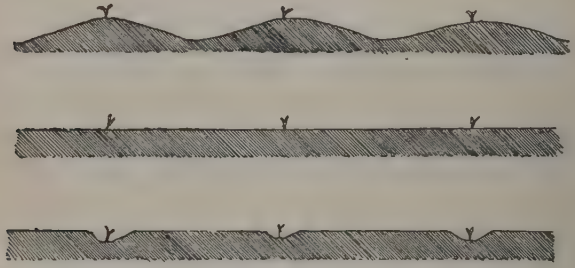


FIG. 57. — THREE METHODS OF PLANTING CORN

The poorer and drier the land, the greater must be the distance between plants. The richer and moister the soil, the more the plants may be crowded. In the South corn is usually planted from the first of March to the middle of June.

**Cultivation.** — Corn roots are long and near the surface; this shows that cultivation ought to be shallow. Heavy rains after planting make some clay lands very compact. This causes some farmers to give one deep cultivation while the plants are very small. Avoid this unless sure that it is necessary, and then make this deep cultivation

on y when the plants are very young. A corn plant six inches high may have roots twelve to eighteen inches long. Many of them would be cut by deep cultivation.

It is possible and wise to cultivate corn before it comes up. This is done by running a spike-tooth harrow or a weeder (Fig. 58) over the field, either across or along the rows. Thus millions of tiny weeds and grass plants are killed

*Courtesy of Tennessee Agricultural Experiment Station*

FIG. 58. — A WEEDER FOR VERY SHALLOW CULTIVATION

just after they have come up. This early cultivation also forms a loose layer of earth all over the field, which holds the moisture in the ground, thus making the corn come up more completely and quickly and causing the young plants to grow more rapidly. This cultivation with the weeder can be kept up until the corn plants are several

inches or even a foot high. One man with a horse or mule can thus cultivate ten to twelve acres in a day.

In the Cotton Belt upland corn is usually thinned to one plant in a hill. Corn should be cultivated as soon after

*Courtesy of Tennessee Agricultural Experiment Station*

FIG. 59. — AN INEXPENSIVE CORN HARVESTER

Note the sloping knife outside the wheels and the platform between for the man who catches the falling plants.

each rain as the soil is dry enough. A cheap implement much used in the South for cultivating corn is the "heel scrape." Various styles of one-horse and two-horse culti-

vators are used. Cultivation usually ceases before all the silks appear. In cultivating corn avoid ridging the land very much, because this takes earth from the middle of the row and because ridging increases the amount of surface that evaporates moisture.

**Fertilizers.** — Corn grows best on rich, moist land, and it pays better to enrich the land by growing cowpeas or other soil-improving plants in previous years than to use large amounts of commercial fertilizers. Manure, applied early, is the best fertilizing material for corn. When this can not be secured, moderate amounts of commercial fertilizers rich in nitrogen may be used on land needing fertilizer.

**Stripping the leaves.** — Many farmers in the South strip off the corn leaves to obtain "fodder" with which to feed their teams. When the farmer strips the green leaves from the corn plant, he stops the accumulation of carbon, the material of which the corn grain chiefly consists. Thus he reduces the yield of corn grain several bushels to the acre. The same amount of labor employed in making hay as in "pulling fodder" would produce much more food for stock. The practice of cutting and shocking the corn plants just after most of the shucks have turned brownish does not greatly reduce the yield and affords considerable forage for use in winter. One kind of machine for cutting corn plants is shown in Fig. 59.

### Practice Work and Questions

1. Examine ten ears of corn and record in your notebook the number of rows on each. Can you find any ear with fifteen rows? Try to discover some law, or rule, about the number of rows.

2. Find ears, or even kernels, of sweet corn and pop corn, and bring these and samples of dent corn ears to the class. Write in your notebook

descriptions of grains of each, noting shape, size, color, and any other points that show likeness or unlikeness.

3. In a field where the stand is thick, measure a space thirty-three feet long and the width of a row. How many square feet in this area? Count the number of corn plants and record this in your notebook. At this rate, how many corn plants are there on an acre (43,560 square feet)?

4. Examine a number of ears of shucked (husked) white corn to find ears having yellow, yellowish, red, or dark-colored grains. Show some of these mixed ears in class. Can you learn from the owner of the mixed ears whether the crossing was due to the white corn being planted too near to the other kinds in the *last* corn-growing season, or in some *earlier* year?

While looking for ears that are evidently mixed or crossed, pick out also some of the best ears with grains of uniform color to be used in practice in judging corn as directed in the next chapter.

5. **Home project.** Write in your notebook, for reading in class, a brief statement showing how you cultivated, or will cultivate, your patch of corn or how the owner cultivated the best field of corn with which you are familiar.

## CHAPTER XX

## SELECTING OR JUDGING SEED CORN

By careful selection of seed corn, five bushels or more to the acre may be added to the usual yield. It pays well, therefore, to learn to select or judge corn (Figs. 61, 62, 63). It is important to select seed from good plants and also from the best ears.

**How to know the best plants.** — The best seed corn is that which is first selected in the field and again selected in the barn or home. These ears should usually be saved only from those plants which (1) bear two good ears, (2) are free from disease, (3) are erect and bear ears not extremely far from the ground, and (4) have shucks that completely and tightly cover the tips of the ears, as a means of excluding corn weevils from the grains. This last condition is especially true for the southern and central parts of the Cotton Belt.

**Using a score card.** — A score card is an outline intended to help one to select the best ears or other individuals. It shows by numbers the relative importance of the desired qualities. Score cards for corn vary slightly in different states. Each pupil should score at least ten ears of corn by using the score card on page 115, or any other that the teacher may supply.

*General directions.* Begin with the second horizontal line in the table, which is for "shape of ear." Carefully

examine the ear to discover whether or not the shape is perfect. Among defects may be slight crookedness, too much taper, or rows of kernels twisting around the cob instead of being straight. A shape that is very good may be scored "9"; a perfect shape, 10, is rare. If there are notable defects in shape, give it some lower number. It may be graded "8", if its only weak point is a moderate twisting of the rows of kernels.

*Courtesy of U. S. Department of Agriculture*

FIG. 60. — A BOY CLUB MEMBER SELECTING SEED CORN

After deciding on the score for each quality, write the figure or grade in the proper blank column in the table. When all the other qualities have been noted, score the first one, "trueness to type."

**Color of grain and cob.** — The color of all kernels on the same ear (or on the same set of ears in exhibits at fairs) should be the same.

The color of the cobs should be uniform for all ears of a given variety. White cobs are preferred if the grain is white, and red cobs if the grain is yellow. The yield, however, is not affected, whether the cob be uniformly white or uniformly red.

**Vitality, or seed condition.** — A germination test shows the vitality most accurately. However, the appearance of the tips of the grains often indicates how they will germinate. Poor, or low, germination results when the tips of the grains are (1) black or brownish, (2) shriveled, (3) covered after being shelled by small bits of the cob, or (4) very slender and sharp-pointed. Usually a grain with well-filled shoulders (Fig. 65) next to the cob and with a large germ produces strong sprouts that make good plants.

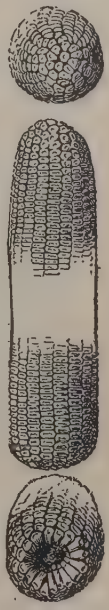


Fig. 61. — Tip, Side View, and Butt of a Prize-winning Corn Ear

**Tips of ears.** — The grain near the tip of the ear should be well shaped and the rows should extend well out to the end of the cob. The less cob exposed, the better (Fig. 62).

**Butts of ears.** — On the butt, or larger end, of the ear there should be straight rows of grains and very few irregularly shaped kernels. The best butts are those in which the grains extend beyond the end of the cob, leaving a medium-sized depression where the ear stalk, or shank, was attached to the cob. Stand the ear on end. If the butt is even, as it should be, the ear will stand erect, or vertical. An ear with a butt much larger than the remainder of the ear or with several extra, short rows of grains is badly shaped.

**Uniformity of kernels.** — Except the grains near the ends of the ear, the kernels on one ear and in one variety should be nearly similar in shape, size, and degree of denting on

the top. When a corn-planting machine is used, it is important for the grains to be of one size, so that the same number may be dropped in each hill.

**Shape of kernels.** — The grains are most compactly arranged when they are almost square-shouldered both at the crown or top and next to the cob. A grain rounded at the top wastes space and is likely to be short. A well-

Fig. 62. — Tips and Butts of Corn Ears
*a*, good; *b*, fair; *c*, poor.

shaped kernel is well filled next to the cob (Fig. 64), giving room for a large germ and the larger the germ, the better. The grain should be large, and it is best when the shape is like those shown at the top in Fig. 65.

**Length of ear.** — The best length differs for separate varieties. If the ears are short, the yield is reduced. If they are unusually long, there is danger that the ear may not be well covered by the shuck. In varieties bearing only one

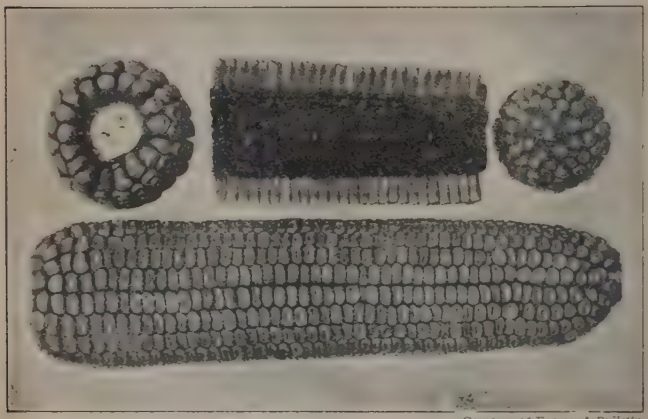
SCORE CARD FOR CORN

| QUALITIES | PERFECT SCORE | EAR NUMBER | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 1. Trueness to type; uniformity | 10 | | | | | | | | | | |
| 2. Shape of ear | 10 | | | | | | | | | | |
| 3. Color of grain and cob | 10 | | | | | | | | | | |
| 4. Vitality or seed condition | 10 | | | | | | | | | | |
| 5. Tips of ear | 5 | | | | | | | | | | |
| 6. Butts of ear | 5 | | | | | | | | | | |
| 7. Kernel uniformity | 10 | | | | | | | | | | |
| 8. Kernel shape | 5 | | | | | | | | | | |
| 9. Length of ear | 10 | | | | | | | | | | |
| 10. Circumference of ear | 5 | | | | | | | | | | |
| 11. Space between rows | 5 | | | | | | | | | | |
| 12. Space between kernels at cob | 5 | | | | | | | | | | |
| 13. Proportion—shelled corn to ear | 10 | | | | | | | | | | |
| TOTAL | 100 | | | | | | | | | | |

FIG. 63

ear to the plant, the ear should usually be more than nine inches long.

**Circumference of ear.** — The measure around an ear is taken with a tapeline at a point one third the distance from the larger end. The usual rule is for the circumference to



*Courtesy of Farmers' Bulletin*

FIG. 64. — CORN EARS SHOWING GOOD BUTTS AND TIPS AND WELL-FILLED ROWS

Note the size of the cob and the close-fitting kernels.

be three fourths the length of the ear. An ear much larger around than this may have too large a cob and may dry out too slowly. A very slender ear may have too small a cob and grains that are too small.

**Space between rows.** — If these furrows are deep and wide, they indicate a poorly shaped, round-shouldered kernel. Such ears yield a low percentage of grain (Fig. 66).

**Space between kernels at cob.** — Spaces between the flat sides of the kernels near the cob show that the grains are not occupying all the room they might (Fig. 67). On such ears the tips of the kernels are likely to be too thin or too flat with a small germ; the grains seem loose when the ear is twisted.

FIG. 65. — VARIOUS SHAPES OF CORN KERNELS

Upper kernels are well shaped; all others, poorly shaped

**Proportion of corn to cob.** — You may determine this by shelling the ear (or half the ears in an exhibit of ten ears) and weighing the shelled corn and the cob. The weight of the shelled grain is then divided by the weight of cob and grain. The quotient gives the percentage of grain on the husked ear. With most highly bred varieties the selected ears are expected to show at least 86 or 88 per cent of grain.

FIG. 66. — CROSS SECTIONS THROUGH CORN EARS

*1*, grains too short; *2*, too much space between rows and cob too small; *3*, kernels well shaped.

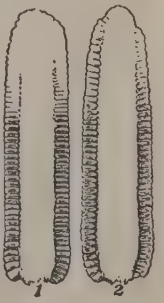



FIG. 67. — SECTIONS LENGTHWISE THROUGH CORN EARS

**Germination test.** — Vacant hills or poor stands greatly reduce the yield of corn. They are often due to planting grains in which the germs are dead or injured. A very even stand may be obtained by testing in any kind of seed germinator (see Chapter III) six grains from every ear of seed corn. Do not use the ears whose grains fail to sprout or that make weak or small sprouts.

### Practice Work and Questions

1. Every pupil should bring to school at least five good ears of corn for use in the game of corn judging, to be played instead of having a recitation. Label each ear to be judged with a number and your name on a small piece of cardboard attached by a long pin stuck into the cob at the extreme butt end. After a few ears have been scored under the teacher's direction, pupils may get practice by scoring and comparing other ears. Be prepared to show defects in ears and to give reasons.

After you have scored the ears you brought and have written the score either on the score card on page 115, or in your notebook, exchange with some other pupils, and score the new ears.

2. **Playing the game and keeping the score.** (a) First place your *largest* ear, considering both length and circumference, on the right, then the next largest, and so on. Write the ear numbers in order in your notebook. When your classmates have arranged their ears by size, you should "progress to the right" so as to examine their corn. As you do this, write down the numbers so as to show the order in which you would arrange their ears when considering only size. Who wins this point? The teacher decides the largest ear or lets the class vote on it.

(b) Again arrange your own ears, this time placing on the right those that seem to you to have the best *shape*. Write the numbers as now arranged. Again examine the corn of your classmates and write the numbers to show how you would arrange those ears when considering only *shape*. Who wins this point?

(c) Next pick off three *grains* from near the center of each of your ears, and spread these, groove side up, opposite their numbered ears, writing the numbers in order. Examine your classmates' grains and write the numbers showing how you would rank them. Who wins?

## CHAPTER XXI

## WHEAT, OATS, RYE, AND BARLEY

These four crops are called the *small grains.* Each is an important human food in some part of the world. Oats and barley are largely used as hay or pasturage. Their straw is fed to live stock or used for bedding. Wheat makes better bread than any other grain.

**Resemblances between the small grains.** — Wheat, oats, rye, and barley all bear seed or grains at the top of a hollow stem, or straw. Although the walls of the straw are thin, the hollow form gives great strength to a small amount of stem material.

Fig. 68. — Part of a Young Barley Plant Showing Large Clasps

These small grain plants are alike in having no taproot, but only a great number of fine roots springing from a center or crown. This crown, or starting place for the permanent roots, is usually about one inch below the surface of the ground, whether the seed be planted deep or shallow. The seeds are sown one to three inches deep.

**Some differences between the plants of wheat, oats, rye, and barley.** — The heads of oats are branched and open, but those of wheat, rye, and barley have grain clusters, or *spikelets,* closely joined to the main stem. The heads of

rye are long, somewhat flattened, and have long beards. Common barley and bearded wheat have shorter heads with stiff, spreading beards. Some of the best varieties of wheat, however, do not have beards.

**How to recognize the seeds of the small grains.** — The threshed grain of wheat, oats, rye, and barley may be distinguished as follows: Oat kernels are wrapped tightly in a long, tough hull. Barley grains are covered with a hull that has grown to the kernel, forming an angular grain. Wheat grains have no hull after being threshed and are short and usually plump. Rye grains, like wheat grains, have no attached hull but are longer and more wrinkled than wheat grains.

FIG. 69. — PART OF A YOUNG OAT PLANT SHOWING THE ABSENCE OF CLASPS

**How to recognize the young plants.** — It is possible to distinguish between fields of these plants when they are small. This can be done by the width of the leaves and the erect or spreading growth. It is sometimes puzzling to decide whether a single young plant is wheat, oats, rye, or barley. On the leaves of young barley, wheat, and rye there are tiny growths like little horns, clasping the stem. These may be called "clasps." They help to identify the plants (Figs. 68, 69, 70, 71). Barley has larger clasps than any other kind of small grain. Wheat has the next largest or medium-sized clasps. They are unlike those of barley and rye and bear on their edges a few very fine short hairs. Rye has still smaller clasps and the oat plant has no clasps.

**The flowers of the small grains.** — Wherever there is a single grain of oats or wheat, there has once been a flower. It had no brilliant color but resembled a flower only in that it had the essential parts, that is, stamens and pistil. The green flower of oats, wheat, rye, or barley before the grain has begun to form contains in each grain place three stamens or pollen cases and two feathery, plumelike stigmas (Fig. 20).

Oats, wheat, and barley do not need bright colors and nectar in their flowers to attract insects, because they are self-pollinated. That is, the pollen in any one flower fertilizes the pistil in that same flower. Self-pollination does not seem to injure plants that are accustomed to it. It keeps varieties of wheat or of oats from mixing with each other through the carrying of pollen by wind or insects. Thus red oats do not naturally cross with Burt or Turf oats. However, rye may be cross-pollinated.

Fig. 70. — Part of a Young Rye Plant Showing Small Clasps

**Preparation of land.** — Good preparation should be given to the land intended for wheat. This grain requires a seed bed that at the time of planting is compact or settled in the lower layers but loose and fine in the upper ones. This is best secured by plowing land for wheat a number of weeks before sowing the seed and then pulverizing the clods with a harrow.

Unfortunately some farmers seem to think that any kind of preparation, or none at all, is good enough for oats. An oat seed is well protected by its hull and can lie for weeks uninjured among dry clods. Nevertheless oats should not be deeply buried under large clods, for this causes the plants

to come up at different dates and to ripen unevenly and makes the stand thinner than it would otherwise be.

**Thickness of sowing small grains.** — When planted at the usual distance, a wheat or an oat plant generally ripens from two to six heads on an equal number of stems or branches. A plant well-fertilized, planted early, and given abundant space may form more than a score of stems and heads.

FIG. 71. — PART OF A YOUNG WHEAT PLANT SHOWING CLASPS BORDERED WITH HAIRS

This habit of branching from buds at the crown permits the plants to occupy as much or more than the usual space. It explains why sometimes just as large a crop comes from sowing two bushels of oats as from sowing three bushels to the acre. About five pecks of wheat or rye to the acre are generally sown.

**Varieties.** — Among the standard varieties of wheat for the Southern States are Blue Stem and Fultz, which are beardless or smooth, and Fulcaster, which has beards. Red oats is the standard Southern kind. It is called rust-proof because it is less injured by rust than most other varieties. The Burt and Fulghum are early Southern varieties. Burt is sown after Christmas. Southern rye affords more forage than does rye seed brought from higher latitudes.

**Time to sow small grains.** — Rye and wheat are usually unhurt by the coldest weather that occurs in the Southern States. Hence, they are always sown in the fall. Barley and winter, or Turf, oats are usually sown in the same season. In the southern part of the Cotton Belt, Red oats

may be sown either in the fall or after Christmas. Wherever oats can live through the winter, the yield is much larger if sown in the fall than if sown after Christmas.

**Increasing the resistance of oats to cold.** — Fall-sown oats are much more productive than those sown later; so it pays to help oats live through the winter. Notice young oat plants on a clay soil late in a cold winter, and you may observe that the whitened roots of many young plants are partly above ground. In this position they are easily killed. The repeated freezing of the water in the soil has lifted them. Water swells in turning to ice; so the ice is forced up above ground. In rising it lifts a little earth, and with the earth the young and slightly rooted plant is carried. When the ground thaws, the uplifted earth, being heavy, falls back into place, but the plant remains in its raised position. This heaving may be repeated several times.

FIG. 72. — A GOOD SAMPLE OF WHEAT

If oats are sown early enough in the fall, they form long strong roots which tend to anchor them. A more certain method of protecting them against death from cold consists in planting them in deep furrows near together and

not entirely filled in. The young plants are safer here because it is more difficult for a plant in a low place to be lifted by a freeze than for one in a higher position.

FIG. 73. — A POOR SAMPLE OF WHEAT; GRAINS SHRIVELED

**Improvement of seed.** —Plump seeds usually produce larger crops than do light seeds (Figs. 72, 73). Both wheat and oats can be greatly improved by selecting the best plants and sowing their seed in a small seed plot. Any improvement once made is likely to be permanent, because wheat and oats do not cross with inferior kinds. On any farm where oats or wheat mature large, plump grains, it is better to use home-grown seeds than those from other parts of the country. When properly cared for, wheat and oats do not "run out" and do not require change of seed.

**Fertilizers for small grains.** — These plants make much of their growth during the cooler part of the year. The vegetable matter in the soil is not then rotting rapidly enough to furnish the plant with needed available nitrogen. For this reason the fertilizer for the small grains ought to be rich in soluble nitrogen. Nitrate of soda is especially suited to them. This can be sown on the growing plants

in spring and need not be covered. Acid phosphate, applied when the seed are sown, is often a profitable fertilizer for small grains. On very poor soils, it may be necessary to add also some form of potash, making a complete fertilizer.

### Practice Work and Questions

1. Examine the heads of oats that have not been threshed, and write in your notebook what you learn on the following points: (*a*) In a cluster of seed, or *spikelet*, is the larger of the two grains the one nearer to or the one farther from the main stem? (*b*) Can you find spikelets having three matured grains? (*c*) To what part of the grain is the beard attached?

2. Carefully examine grains of rye and wheat, and point out in class any differences between them that you find. Can any members of the class tell how the heads of rye and wheat differ in appearance?

3. Bring to school, if possible, young plants of any small grains; show by the clasps which is (*a*) rye, (*b*) oats, (*c*) wheat, and (*d*) barley.

4. Make drawings showing the shape of (*a*) a grain of wheat and (*b*) a seed of oats.

5. Find out what varieties of wheat and of oats are grown in your neighborhood. Bring to school a few heads or ounces of grain of as many of these as you can get. The teacher will let the pupils examine the specimens brought by all. Find out and write in your notebook as many differences as you can discover between any two named varieties of wheat or any two varieties of oats.

## CHAPTER XXII

## COTTON

Every nation depends largely on the southern part of the United States for cotton. The Chinaman, as well as the Englishman, is clothed in American cotton. All classes, from beggars to princes, make use of it, and the world is

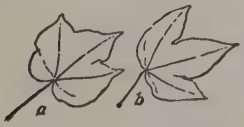



FIG. 74. — COTTON LEAVES
*a*, upland; *b*, sea-island

FIG. 75. — COTTON BOLLS
*a*, upland; *b*, sea-island; *c*, Indian

continually calling for more. Foreign countries send more gold into the United States in payment for our cotton than for any other American crop.

**Production.** — The cotton crop of the Southern States, which is usually between 11,000,000 and 14,000,000 bales a year, generally sells for an amount between $800,000,000 and $1,200,000,000, including the seed.

The next largest producer of cotton is India. Most Indian cotton, however, is of poorer quality and lower price than the American. Egypt stands third as a cotton-producing country. Its product has a very long staple and

sells for a higher price than American cotton. Some of it is imported into the United States for use in making goods where a long staple is required. In length the Egyptian staple is between that of American long-staple and the sea-island variety. Egyptian and Indian cottons are not nearly so productive in America as are the varieties generally grown in the Southern States.

FIG. 76. — FIBERS OR STRANDS OF COTTON, ENLARGED

**The cotton plant.** — Cotton belongs to the mallow family, which includes not only all kinds of cotton, but also okra, hollyhocks, and a number of common weeds and flowers.

*Courtesy of N. C. Extension Service*

FIG. 77. — A COTTON PLANT OF AN EARLY AND PRODUCTIVE TYPE

The several kinds of cottons differ greatly in their stalks, leaves, blooms, and lint (Figs. 74, 75, 78). In tropical countries, cotton is a treelike plant that does not die in winter. In the southern part of Texas cotton plants, springing from roots that live over winter, are troublesome because they give food to the cotton-boll weevil early in the spring.

**Why cotton makes strong thread and cloth.** — Cotton is popular for making thread, cloth, and rope,

in spite of the fact that a single fiber of the common kind is usually not over one inch long. This is because a cotton fiber is a twisted hollow tube (Fig. 76). The twist makes the separate cotton fibers cling tightly to each other, just as two chains would do if twisted together. The fibers are so small that 1200 could be laid side by side in the space of one inch.

**The kinds of cotton in the United States.** — Only three

*Courtesy of North Carolina Agricultural Experiment Station*

FIG. 78. — COTTON FIBERS SPREAD OUT FROM SEED TO SHOW DIFFERENT LENGTHS OF STAPLE IN TWO "SHORT-STAPLE" VARIETIES

main kinds of cotton are grown in the United States. These are: (1) common or short-staple, (2) long-staple upland, and (3) sea-island cotton. Long-staple upland cotton resembles common cotton very much in appearance and has the same shape of leaf; but its bolls are usually more slender and the lint longer, being about one and one eighth to one and one half inches long. This extra length makes it worth several

cents more a pound. However, long-staple cotton is not so productive of lint as the best varieties of short-staple and is generally a little later in maturing. It prefers bottom land. Among the popular varieties are Express and Webber.

Sea-island cotton is a tall, slender plant with branches, leaves, and blossoms differing from the other kinds.

**The kind or variety to grow.** — There are several hundred separate names, but many of these are merely new names for well-known old varieties. Most important is a high yield of lint to the acre. A high percentage of lint is often a means of securing the desired productiveness. Large bolls are advantageous in making picking easier and quicker. Earliness, or medium earliness, is now essential, since the cotton-boll weevil is quite sure to ruin late varieties. The fiber must not be unduly short (Fig. 78).

*Photo by W. E. Hinds*

Fig. 79. — Plant Representing the Big-boll Group

**Examples of very satisfactory varieties.** — There is no one variety best for all soils and seasons. (See Figs. 77, 79, 80.) A productive one is Cook Improved. This has rather large bolls, a high percentage of lint, and is rather early for a big-boll kind. Cleveland is another productive

kind with big bolls. Both of these have the disadvantage of easily falling out of the boll. Cook Improved is especially liable to rotting of the bolls. Lone Star and varieties of the Triumph — a storm-proof type — have proved well adapted to Texas and Oklahoma, as well as to some other regions.

Fig. 80. — Typical Plant of Upland Long-staple Cotton

On many of the soils of the southern part of the Southeastern States where cotton wilt or black rot occurs, it is necessary to grow varieties that have been bred for resistance to wilt disease. Among these are some strains of Toole, which has small bolls, and some strains of Cook, having larger bolls.

**Breeding cotton for the community.** — Even in a pure variety there are poor, medium, good, and very good plants, though all may have had equal chances. Hence, it is very easy to improve cotton by selecting seed from the best plants. The yield and the percentage of lint in the seed cotton may be increased, the bolls made larger, the lint longer, and the plants earlier or shorter-jointed. However, all of these can not be attained at the same time. It is best to start with a pure variety that is satisfactory in

all but one quality, and then select from good plants that make the nearest approach to this desired quality. The first rule in cotton breeding is to select chiefly for one quality at a time and to keep up this selection for the same quality every year.

The second rule is to keep separate the seed of each of the best twenty or more mother plants and to grow each in a separate row the next year. The seeds from the best rows should be saved. Always locate the breeding patch as far from other cotton as possible. Insects carry cotton pollen and thus mix varieties, but not to the same extent that the wind causes the mixing of varieties of corn.

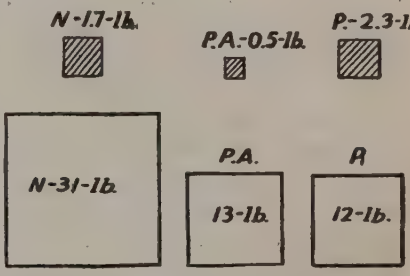



FIG. 81. — SHOWING AMOUNTS OF NITROGEN, PHOSPHORIC ACID, AND POTASH REMOVED FROM THE SOIL BY 500 POUNDS OF COTTON LINT (above) AND 1,000 POUNDS OF SEED (below)

In breeding cotton the main aims are to obtain productiveness, earliness, and at least medium length of staple. Early plants can often be recognized before maturity by their short joints, their few and short *sucker* branches, and the location of most of the bolls rather near the base of the plant.

An opportunity for usefulness and profit is afforded to some of you who study this book if you will make it your business through the years to keep pure and improve a good strain of cotton and to supply seed to your neighbors. The entire community ought to agree to grow the same kind of cotton. By producing a uniform quality of lint, all neigh-

bors will obtain a higher price than if they grow various kinds of cotton.

**Preparation of land and cultivation of cotton.** — Thorough and deep preparation usually pays. Cotton comes up better if the harrow is used to prevent the formation of a crust and the drying of the land during the few weeks before the seeds are planted. Cotton is planted as soon as danger of frost is past. Cultivation should be shallow and frequent, and, if possible, after rains and before a crust forms on the soil, rather than at regular intervals. On poor land the rows may be as narrow as three feet. As the land becomes richer or is better fertilized, the branches grow longer and the plant requires more space to attain full size. However, experiments have proved that crowding the plants closely together in the row prevents the formation of sucker branches, hastens maturity, and thus, when boll weevils are abundant, increases the yield of cotton.

**Fertilizing cotton.** — Usually a complete fertilizer (see page 92) is employed. It should contain two to three times as much phosphoric acid as nitrogen or potash (see Fig. 81 and page 93). On soils where cotton rust is usual the proportion of potash may be increased. If the plants make a very small growth on any soil, the proportion of nitrogen should be increased, but an excess or very late application delays maturity. The tendency of phosphate and of all well-balanced fertilizers is to hasten maturity of the cotton plant.

### Practice Work and Questions

1. From single seeds of unginned cotton carefully straighten out the fibers until each seed and its attached lint has the shape of a butterfly with outstretched wings. Try to measure what you think is the average length of the fibers.

2. Write in your notebook the names of the varieties of cotton grown in the neighborhood. Which of these have large bolls? Small bolls? Long staple?

3. Examine ten plants or even ten dead cotton stalks to notice how widely they differ. Would there be any advantage in selecting seed from uniform plants? Decide from which kind of plant you would select. Why?

4. Do all the bolls on one plant have the same number of locks? Can you decide this by examining the empty burs?

In the variety most grown near the school are the bolls more numerous that contain four locks or those that have five locks?

5. Count and record the number of seeds in each lock of a boll of cotton. Do you notice any difference in size or shape or in the color or abundance of the short fuzz that covers each seed?

6. Find bolls only partly open. By pulling, compare the strength of such immature fibers with that of fully opened mature bolls.

7. When the next cotton crop is mature, would you like to begin to select and improve cotton by the methods described in this chapter?

## CHAPTER XXIII

## SUGAR CANE

Both sugar cane and corn belong to the grass family. Safely hidden under the clasping or tubelike lower portion of each leaf are buds or eyes, one at each joint. These serve instead of seed to multiply the plant.

When a stalk of sugar cane is planted, the moist, warm soil causes the buds to grow into young sprouts, which for a short time feed on the juice of the mother cane.

**Roots and suckers.** — At each bud or eye and extending entirely around the stalk are several rows of small whitish dots. If cane is planted and a few weeks later dug up, it will be found that the roots have grown out from these spots.

Unfortunately these dots, especially in some varieties, also throw out roots when the cane is blown down and lies touching the damp ground. Roots from the joints above ground are not wanted. In a row where only one continuous line of cane has been planted, there may be single hills from each of which three or more canes may grow. The first grew from a planted bud; the others from buds on the base of the young cane. Stalks that grow from a bud on a young plant, rather than directly from a bud on the planted cane, are called *suckers*. Suckers that start early add to the yield, but those that form late are useless.

**The plant changed by climate.** — Sugar cane, like cotton, first grew in countries warmer than the Southern States. Like cotton also, it has greatly changed its habit of growth

*Photo from Keating*

Fig. 82. — Cutting Sugar Cane in Louisiana

as it has been carried northward. In the tropics it continues to grow fifteen months or more before being cut.

In Louisiana the tops can not live through the winter, but the stubble and roots remain alive and furnish a supply

of shoots for a second and sometimes for a third crop. Planting, therefore, is necessary only every second or third year. Only once in a number of years is planting necessary in tropical countries. In the central part of the Gulf States and farther north, the roots usually do not live through the winter, so that stalks of cane have to be planted every year.

**Varieties of sugar cane.** — Sugar cane forms seeds in very warm countries but not in the Southern States. The chief use of these seeds is to start new varieties. Plants grown from seeds are more unlike their parents than are those propagated from buds. When a seedling is better than its parent, it is prized as a new variety and is increased by planting canes.

The kind most generally grown is the red or purple cane, so named from the color of the stem. Some of the newer varieties introduced by the Louisiana Experiment Station are proving superior to all the old varieties and are displacing them in Louisiana. One of these, called "L. 511," is more resistant than most other varieties to the mosaic disease. To avoid this disease and some others, plant only healthy stalks.

**Bedding.** — Since sugar cane grows from the succulent buds on the canes planted, these buds must be kept through the winter in such condition that they will not freeze, dry, or shrivel. In Louisiana a part of the cane is planted in the fall, the soil protecting the buds until the warm, growing weather in the spring, when another part of the crop is planted. In the fall the canes intended for planting in the spring are placed with their leaves overlapping, like shingles, in the water furrow of certain rows and covered with earth. When spring comes, these are taken up and planted.

Farther north cane for planting is kept over winter in beds or heaps covered with earth. In these cooler regions it is usual to dig, rather than to cut, cane intended for planting.

**Enriching the land.** — In Louisiana a field to be put into cane the next year is planted this year in corn, and cowpeas are sown thickly in the corn. The entire growth of cowpeas is turned under by the use of immense plows. This enriches the land by furnishing vegetable matter and nitrogen. Sugar cane is then grown on that field two or three years. The Louisiana Sugar Experiment Station found that a winter growth of annual yellow *bitter clover* greatly increased the next crop of sugar cane. On the sandy soils of the southern part of Georgia and Alabama, a crop of velvet-bean vines is sometimes plowed under to enrich the soil for the succeeding crop of sugar cane.

**Preparation and cultivation.** — On stiff soils of Louisiana the main need is drainage. The land there is plowed into high ridges 5 or 6 feet wide, and rather deep parallel ditches are dug a few rods apart. In other states sugar cane is grown chiefly on sandy bottom land. North of the Sugar Belt the cane is planted early in spring, using either a single or a double line of canes in each row. Cultivation must be shallow and frequent.

**Soils and fertilizers for sugar cane.** — Every green leaf throws off into the air moisture brought up from the soil. Hence, to supply enough water for such a large leaf surface as a cane field presents, the soil must be well supplied with moisture. No common crop requires more water. Bottom lands, therefore, are usually best for cane. They must be naturally rich or made so by plowing under a crop of cowpeas, velvet beans, or other leguminous plants.

On lands not very rich, commercial fertilizers are profit-

*Photo from Ewing*

FIG. 83. — LOADING SUGAR CANE NEAR BATON ROUGE

ably applied for the growing of sugar cane. A fertilizer for this crop should be rich in nitrogen and should usually contain also phosphoric acid and potash. Four hundred to seven hundred pounds or more of a complete commercial fertilizer is an ordinary quantity for an acre.

**Yields of sugar cane.** — In Hawaii, where the canes are allowed to grow much longer than in the United States before being cut, the yield has been as high as 100 tons of cane to the acre. Irrigation is largely responsible for the large yields in those islands. This greatly increases the yield on well-drained land in the Southern States. A good average yield for an entire sugar estate in Louisiana is 20 to 30 tons an acre; for sandy pine lands, 15 to 20 tons. A good yield of sirup is from 300 to 600 gallons to the acre. Large steam mills press the juice from the cane much more completely than do the small mills worked by horse power. The large plantations are equipped with very large and expensive mills.

**Making sirup.** — The usual outfit for a small cane mill and evaporator is not expensive. The evaporator is a large shallow pan with a copper bottom. In this the juice is boiled until thick enough for sirup. It is usually placed just above a furnace. Sometimes boiling is done by steam, carried through coils of pipes laid in the bottom of the evaporator pan.

Even experienced sirup makers can make a more uniform article by placing in a bottle of the hot sirup a simple instrument (Baumé hydrometer) for showing how thick it is. When this sinks to a point between the marks 34 and 35 degrees on the instrument, the boiling is stopped.

To prevent a part of the sirup turning to sugar, it may be put in cans or jugs while still very hot and tightly sealed

to exclude the air. The heat kills the germs and thus keeps the sirup from fermenting.

### Practice Work and Questions

1. If growing or bedded sugar cane is available, ask permission to examine a few stalks. Locate the *root dots* at each joint, and note the position of leaves, the distance between joints, and any other points that are mentioned in this chapter.

2. Are all the buds alike in size and plumpness? Do any of the buds appear small and immature or shriveled or diseased? Such eyes will probably not sprout when planted.

3. Are uppermost "joints" as sweet as those near the base and central part of the plant?

4. Ask permission to dig the stubble and upper part of the roots of one plant of sugar cane to be examined at school by the class.

5. If no sugar cane is grown near you, substitute sweet sorghum and make on it the observations required in Exercises 1, 2, and 3.

6. Can you write a short composition on "How Sirup Is Made"? If not, you can learn this interesting process when some neighbor makes his next lot of sirup. You might help him by writing in advance to the United States Department of Agriculture at Washington, asking for its free bulletin on the best methods of making sirup.

## CHAPTER XXIV

## SWEET POTATOES

The greater part of the sweet potato crop of the United States is produced on the sandy soils of the South. Storage houses now make it possible to market the crop throughout the winter and spring, when prices are higher than in the fall. Sweet potatoes cured in such houses can be shipped by car-

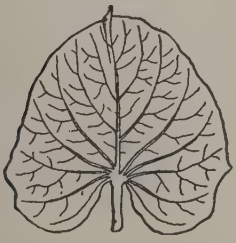


FIG. 84. — ONE FORM OF SWEET POTATO LEAF

FIG. 85. — ANOTHER FORM OF SWEET POTATO LEAF

load lots to distant markets. Hence the sweet potato is now a more profitable sale crop than formerly. Moreover any surplus makes good feed for hogs.

**Buds and slips.** — The sweet potato is propagated from buds instead of from seeds. These buds may be seen after the potato has been kept moist and warm for a number of

days. Sweet potatoes are placed in a potato bed of sand or sandy loam to make the buds grow into shoots, which are called *slips*. The potatoes are pressed into the sand or soft earth and covered with another layer of sand. The bed should be made about six or seven weeks before the time when the slips are to be placed in the field.

**Fire-heated beds.** — To obtain very early plants special beds are made on sloping hillsides and heated by wood burned in a fire box at the lower end of the bed. The smoke and heat are carried in a covered trench cut in the soil under the bottom of the bed of sand; the smoke escapes through a flue rising from the upper end of the long trench.

**Setting the slips.** — When there is danger of frost, the bed must be covered. After all danger has passed or after the time when cotton comes up, the slips are gently pulled from the mother potato and transplanted in the field. They are usually placed about two feet apart in rows or beds three to four feet wide. They must be quickly put into the ground so that their roots may not become dry.

If the soil is dry, a little water should be poured around each slip, thus settling the earth about its roots. Then be sure to cover the wet spot with a layer of dry soil, so that the water added may not pass off into the air. After the slips have made vines more than two feet long, these may be cut off in sections at least a foot long and planted. Press the middle of the cut vine into the soil. Sweet potato slips may be set out by a transplanting machine.

**Varieties.** — There are many varieties. These differ in flavor, earliness, yield, shape of leaf (Figs. 84, 85), and length of vine. Southern consumers like those which, when cooked, become soft and very sweet. Among such varieties are the Nancy Hall, the Porto Rico, and the Dooley.

Varieties having a firm and mealy character when cooked, such as the Jersey and the Triumph, are preferred in some Northern markets.

**Fertilizers for sweet potatoes.** — The sweet potato needs a complete fertilizer. A crop of sweet potatoes removes much plant food; hence it should usually be followed by a leguminous crop. Several diseases attack sweet potatoes, and the germs that cause them remain in the soil. Hence, sweet potatoes ought not to be grown on the same land for two years in succession.

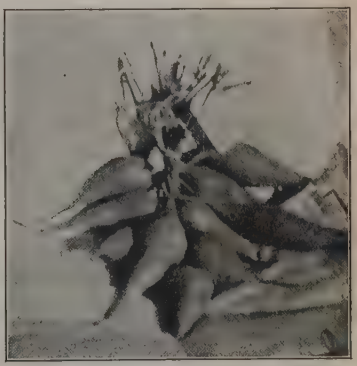


FIG. 86. — SWEET POTATOES FROM ONE PRODUCTIVE PLANT

**Storing and curing.** — Sweet potatoes keep better if dug before frost. The utmost care should be taken in handling them to prevent bruises. Cuts and bruises admit germs, which cause rotting.

Sweet potatoes are stored in banks. They are often heaped on straw or leaves on a well-drained spot. Straw, hay, or cornstalks are placed in a thin layer around the heap. A covering of earth nearly to the top of the pile is then put on, leaving the extreme top of the pile uncovered with earth, so as to afford ventilation. When freezing threatens, the top of the pile should be covered more completely.

A house built for the purpose of curing and storing potatoes is more satisfactory, and in it they remain sound for many months (Fig. 87). It should have tight double walls

with an air space between. The house should have ventilators and should contain slatted bins, open on all sides, and a stove for heating and drying the air when needed.

For ten or twelve days just after the potatoes are dug the temperature of the house is kept at about 85° F., which cures the potatoes by drying out a part of their moisture. Then a cool temperature is desired, but not much below 50°.

*Courtesy of Alabama Extension Service*

FIG. 87. — A SWEET POTATO CURING HOUSE FOR 15,000 BUSHELS

### PRACTICE WORK AND QUESTIONS

1. Examine an Irish and a sweet potato. Do the roots extend through and beyond the sweet potato? Beyond the Irish potato? Which is a true root? The other, at the end of an underground stem, is a *tuber*.

2. If any work with sweet potatoes is going on near the time that this lesson is studied, such as bedding, transplanting, or the like, you should help and should write in your notebook just how the work is done. Doubtless your teacher will give you a grade on a report of any "home project," that is, any farm or garden work done at home.

## CHAPTER XXV

## PEANUTS AND WATERMELONS

Years ago roasted peanuts were eaten merely for the pleasant taste. Now the peanut is known to be one of the most nourishing of foods. We eat it in the form of roasted or salted peanuts, candy, peanut butter, and peanut oil.

Hogs fatten rapidly when turned into peanut fields, and peanut meal is a most nutritious feed for all classes of live stock. Therefore, there has come a great increase in the production of this crop in most of the Southern States.

**The peanut plant.** — There are two principal kinds of peanuts, the Spanish (Fig. 88) and the runner. The Spanish varieties have short, upright stems and small pods, which are firmly attached to the plant. The runner peanuts have larger pods and require more labor in harvesting.

The peanut is a legume and hence is able to make the soil rich if consumed by hogs on the land where the crop is grown. It has the curious habit of maturing its seeds underground. To do this, the plant pushes its sharp needlelike pistils into the ground, where the tips enlarge and become pods containing seeds (Fig. 89). These long pistils can not enter hard soil. This is the reason that the peanut plant is best suited to mellow sandy land. The surface must be kept loose by cultivation until the needles are ready to push

into the soil; after this the cultivating implement should not disturb the soil close to the plant.

By observing carefully you will learn many other interesting facts about the growing peanut plant.

FIG. 88. — A BUNCH OF SPANISH PEANUTS.

**Growing and curing peanuts.** — Since the peanut plant has tubercles on its roots, it can secure its nitrogen from the air. Peanuts should usually be fertilized with phosphate and some potash. Lime often increases the yield and is believed to be one means of decreasing the number of "pops," or empty hulls.

Planting is done after the soil becomes thoroughly warm in spring. A fair yield is thirty to fifty bushels to the acre. Larger yields are often obtained by liberal fertilizing and thick planting. To avoid missing spaces in the field a farmer should plant only sound seed that have been carefully shelled only a few days before planting time.

Peanuts should be dug as soon as mature and cured in tall, slender shocks (Fig. 90). The plants are carefully placed around a pole near the base of which short crosspieces are nailed to keep the peanuts off the ground. The

nuts are placed inward and protected from weather and birds by their own vines. After curing, picking is done by large machines. Peanut tops make satisfactory hay.

**Watermelons.** — Every Southern farm needs its water-

Fig. 89. — Peanuts Forming Underground
Note sharp pistils or "needles" and enlarged tip.

melon patch for producing melons for home use (Fig. 91). The watermelon is also an important sale crop. From some localities thousands of carloads are shipped each year. Varieties for shipping should have a firm rind.

The decay that often occurs during shipment may be prevented by cutting off the tip of the attached stem of the

FIG. 90. — PEANUTS DRYING IN SHOCKS

watermelon and painting the fresh cut with a mixture of bluestone, boiled starch, and water. The bluestone kills the germs that cause decay.

The watermelon likes a warm, sandy, well-drained soil. If the soil is poor, manure should be freely used. The field should be thoroughly plowed and then marked off into checks 10 by 10 or 10 by 8 feet. Where these check fur-

rows cross, work into the soil one or two shovelfuls of well-rotted compost, made of manure and woods earth or of manure and cotton seed. On the manure, sprinkle a handful of complete commercial fertilizer, or guano. With a hoe mark two trenches one inch deep across each hill. In the spring as soon as the soil begins to get warm, plant at least

Courtesy of Extension Division, University of Tennessee

FIG. 91. — A WATERMELON FEAST

six seeds in one of the trenches. A week later plant a like number in the other trench in each hill. Thus if frost kills the earlier plants, there will be later ones to take their places.

Thin to two plants in a hill and cultivate shallow, frequently, and in both directions. Avoid unnecessary moving of the vines or cultivation while the leaves are wet. To

produce large melons pinch off all fruits except one or two on each plant.

Do not plant watermelons for more than one year on or near the same field. A very fatal disease, watermelon wilt, is especially liable to attack watermelons planted on land on which the same crop has recently grown. Where this disease occurs, it may be necessary to fertilize only with woods mold and commercial fertilizers, the manure being left

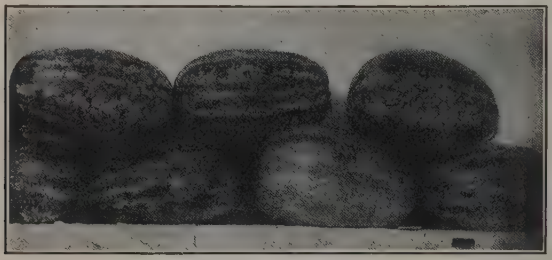


FIG. 92. — WATERMELONS

off. This is because manure frequently contains and carries the germs of the disease. Wilt-resistant varieties of watermelons are now being perfected.

The germs that cause certain other diseases which attack leaves, stems, and melons are sometimes carried on the seed. Hence, these diseases may be prevented by soaking watermelon seed for five minutes in water to each pint of which has been added one little tablet of bichloride of mercury. This is a violent poison for men and animals as well as for germs. It is also often necessary to spray watermelon vines with Bordeaux mixture, which may be prepared as shown in the Appendix.

### Practice Work and Questions

1. When peanuts begin to form nuts, examine them carefully to find the flower, the pistil, and the seed. Notice the position of the leaves of peanuts at night.

2. Are there tubercles on the roots of peanuts? Are they as large as those on the roots of velvet beans? Is any of the soil from the field where peanuts last grew brought to the new peanut field on the planted seed? Think of this when you study the next chapter.

3. When watermelons bloom, notice the difference between the pistillate and the staminate flowers. Observe whether the leaves are green and healthy or spotted by disease.

4. How many leaflets (little leaves) make up one peanut leaf? In the picture (Fig. 89) point out the two leaves (including the leaf stems); the four leaflets on the larger leaf; the three sharp white pistils or "needles"; the bloom; and the roots. Have you ever noticed the color of peanut blooms?

5. What pupil in this class will be the winner in a drawing contest? Make drawings showing (*a*) whole peanuts in half of a pod split open lengthwise and (*b*) the outside of a peanut pod. Label your drawings to show the name of the variety and your initials.

6. Is any member of this class a close enough observer to find a part of the peanut plant that most growers of peanuts have never noticed? This is the tiny projection at the base of each leaf stem. It is called a stipule. Look for it also on plants of vetch, clover, beggarweed, and other legumes, and note differences in size, shape, etc.

7. **Home project.** In choosing a crop for your next "club acre" or home project do not forget to consider the peanut and the watermelon.

## CHAPTER XXVI

## THE INOCULATION OF LEGUMINOUS PLANTS

In former times learned men thought that mankind would finally starve to death because there is not enough nitrogen in the ground to produce food sufficient to feed the growing population of the world. There is no longer any fear of this, for it is now known that certain plants (legumes) can make use of the limitless amount of nitrogen in the air.

**Fertilizer from the air.** — There are about 36,000 tons of this nitrogen gas in the air above every acre. Yet cotton, corn, wheat and grasses can not use a pound of this nitrogen gas until it has been changed into fertilizer nitrogen. This change is made chiefly by leguminous plants. Any of the legumes, for example, the cowpea or clover (Fig. 93), by the aid of the tubercles on its roots can grow on ground where cotton, corn, or wheat would starve for want of nitrogen.

**The farmer's tiny helpers.** — As we have learned in an earlier chapter, every tubercle on the roots of clover or other leguminous plant is a fertilizer factory. Let us get acquainted with the workmen inside the tubercle that change the nitrogen of the air into a form that plants can use. Since the tubercle or fertilizer factory is very small, the workers in it must be extremely minute. Indeed each is

smaller than a speck of dust; so small indeed that 25,000 could be placed side by side on a line only one inch long. These little workmen are really *germs*, or living things. The plant on which germs grow is called the *host* plant.

The germs that work in tubercles live on the sugar and other materials in the sap of the host plant. They repay the host plant by sending up in its sap the nitrogen that

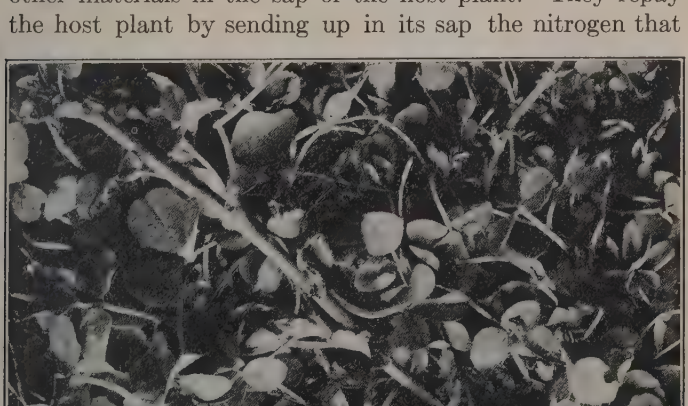
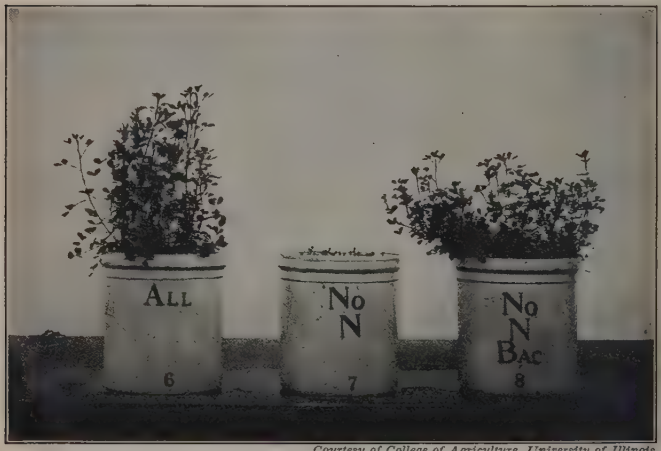


FIG. 93. — WHITE CLOVER

they have gathered from the air and changed into plant food.

**Each kind of germs grows only on the kind of plants to which it is accustomed.** — Every tubercle on the roots of legumes is inhabited by thousands of useful germs, or plants, too small to be seen by the naked eye. When the tubercle decays, these germs are set free and spread through the soil by means of water. These little workmen are alive.

They can not multiply until the same kind of legumes is planted there again. As soon as a clover plant grows there, the clover germs attach themselves to its roots, multiply rapidly, and form a tubercle. Strange to say, clover germs will not grow on cowpea roots. Perhaps this is because the clover germ has become accustomed to living on the




*Courtesy of College of Agriculture, University of Illinois*

FIG. 94. — EFFECT OF INOCULATION ON SWEET CLOVER

On the left a complete fertilizer was used but plants were not inoculated; on the right germs supplied the nitrogen; in the center plants received no nitrogen and were not inoculated.

special kind of food it finds in clover sap, and perhaps the diet the cowpea or alfalfa offers does not agree with it. If a fertilizer factory is started, it must be by germs accustomed to work on that kind of plants or on those very closely akin. Clover germs make tubercles on clover; alfalfa germs

cause nodules on alfalfa; vetch germs organize fertilizer factories on the roots of vetch, and so on.

**Inoculation of leguminous crops.** — If a farmer, therefore, desires to grow clover on a soil where there have been no clover tubercles, he must place the clover germs there (Fig. 94). He can do this by sowing in that place soil from

*Courtesy of College of Agriculture, University of Illinois*

FIG. 95. — EFFECT OF INOCULATION ON COWPEAS IN ILLINOIS SOIL
On the left a complete fertilizer was used without inoculation; on the right germs supplied the nitrogen; in the center plants received no nitrogen and were not inoculated. Cowpeas do not require inoculation on most Southern soils.

a field where clover has turned loose its millions of germs. If he wishes to grow alfalfa, he may likewise sow on the new field soil from an old alfalfa field. *Inoculation* is the name given to this placing of the proper germs where they can form tubercles. To inoculate a legume is to bring the proper germs to its roots.

**How to inoculate legumes.** — Legumes may be inoculated in several ways: (1) by sowing soil, (2) by dipping the seed in water mixed with this soil, or (3) by mixing the seed with a special commercial preparation called a *pure culture*, which is made originally from ground-up tubercles of a plant like that to be grown.

**Using the proper soil.** — Soil for inoculation should usually be taken from a spot where a similar plant has recently been grown. Care must be observed not to use soil that has in it seeds of bad weeds or that contains the germs of serious plant diseases. Promptly cover inoculated seed or soil used for inoculating legumes, for much sunshine will kill the germs that cause tubercles to grow.

**Legumes that need inoculation.** — There are or have been tubercles on nearly every cowpea plant found in the region where cotton grows, for in the Southern States, where cowpeas are generally grown, the wind has blown the germs into almost every field. However, in most sandy soils in the South, where crimson clover, vetch, and alfalfa are seldom grown, the farmer may need to inoculate the seeds of these three very useful plants.

**Other germs in the soil.** — The soil is full of life. It swarms with living creatures. Most numerous of these are germs, or *bacteria*. These are tiny plants far too small to be seen with the naked eye. They lack green coloring matter and multiply rapidly by dividing their own bodies. The farmer could not grow profitable crops without the assistance of several kinds of helpful germs. You have learned about one kind, the nitrogen-trapping germs, which do their useful work while sheltered within the tubercles on the roots of leguminous plants.

Crop plants can not use the nitrogen from the legume

plowed into the soil until *nitrate-forming germs* have further changed it. These microscopic friends of the farmer cause vegetable matter to rot and thus to change its unavailable nitrogen into *nitrates*. The nitrates are soluble or available to the roots of the other crops that grow where leguminous plants have been plowed into the soil.

For these nitrate-forming germs to increase rapidly and thus to benefit the soil and the crop, they need the following conditions in the soil: (1) an abundance of vegetable matter for the germs to feed on and to change into fertilizer; (2) a soil that is always moist, but well drained; (3) a soil kept so loose and well drained that air can circulate in it; (4) an abundance of lime to keep the soil from becoming sour; (5) a warm temperature.

### Practice Work and Questions

1. Carefully dig up and bring to school the roots and root tubercles of at least two growing leguminous plants. Notice what differences there are in the size and shape of the tubercles.

2. Make a drawing of tubercles and of the root to which they are attached.

3. Ask your parents whether any neighbors have inoculated vetch, crimson clover, or alfalfa with either pure culture or suitable soil. What were the results? At the Alabama Experiment Station inoculation once more than doubled the yields of all these plants.

4. **Home project.** Possibly your parents will order pure cultures for you to make such an experiment, or for the class to make the experiment on soil where one of these plants is to be grown for the first time. If so, be sure to leave a little spot without any inoculation and where germs from the inoculated land will not be washed in. In making such an experiment, should you first sow the inoculated seed or those not supplied with germs?

You may make a similar experiment by using suitable soil for inoculation, getting it from a spot where there is no serious disease of plants.

## CHAPTER XXVII

## SOME LEGUMINOUS PLANTS FOR FORAGE AND SOIL IMPROVEMENT

We must now become better acquainted with some of the leguminous plants that are most useful to Southern farmers for hay, pasturage, or soil improvement.

FIG. 96. — PARTS OF VELVET BEAN PLANT SHOWING LEAF, BLOSSOM, AND POD

**Cowpea.** — There are many varieties of cowpeas. Some grow almost upright and are easy to mow. Others make long runners and are hard to mow because they tangle. Cowpeas may be planted in May or June or even later. In cornfields and when grown alone, cowpeas may be sown either broadcast or in drills. The fertilizer most frequently needed is acid phosphate.

Unfortunately the cowpea is severely injured by Mexican bean beetles (Fig. 169), so that where these insects become abundant farmers may need to substitute velvet beans or other legumes.

**Soy bean.** — This annual legume (Fig. 44) is commonly

used like the cowpea for hay, seed, and soil improvement. It has the advantage over cowpeas that the hay does not tangle and that the seed are threshed out instead of being picked. It is sown in May or June in rows.

Fig. 97. — The Bunch Velvet Bean

**Velvet bean.** — This is an annual legume (Fig. 96) that grows in the hot season. Most varieties make long vines and produce most seed if they are supported above the ground. Hence velvet beans are usually planted in cornfields where the vines twine around the cornstalks. The Bunch variety does not overrun corn plants (Fig. 97).

Most varieties of velvet beans do not mature until fall. Cattle are turned into the field after frost and readily eat the matured beans, the frosted leaves, and a part of the vines. The velvet bean is less subject than the cowpea and soy bean to certain diseases and to injury by the Mexican bean beetle.

FIG. 98. — LESPEDEZA, COMMONLY CALLED JAPAN CLOVER

**Beggarweed.** — This plant is an erect legume that matures a few months after the seed are sown. It is especially suited to deep sandy soil near the coast. It is not attacked by the two diseases, root knot and wilt, which injure many other legumes.

**Kudzu.** — This plant is a perennial legume. Its long tangled vines make good hay. Kudzu may also be grazed. It is propagated by rooted cuttings. The foliage is killed by the first frost.

**Japan clover.** — This is a soil-improving plant but not a true clover; hence soil from near its roots will not inoculate crimson or red clover. Its true name is Lespedeza (Fig. 98). It is the best pasture plant among the legumes for the poorest Southern soils. It grows wild over the greater part of the Southern States. Although an annual, it comes up

every spring from seed shed the preceding fall. The seed may be sown in early spring alone or on a field of oats. On rich, moist land it sometimes grows tall enough to be mowed. The pasturage and hay are very nutritious.

**Vetches.** — These annual plants (Fig. 46) have slender stems, or branches, too weak to stand alone. Hence they need to be sown with oats or wheat, so that the weak vines may climb up the grain plants and thus be lifted high enough for mowing in May. Vetches are useful for hay, for pasturage, and for enriching the soil. Hairy vetch is the most popular kind. The seed should be sown broadcast in the fall, two to four pecks of vetch seed to the acre being mixed with the usual amount of seed of wheat or oats. Vetch has an advantage over crimson clover, for, unlike clover, it can reseed the land. If the farmer will let vetch plants form seed, these seed, dropped in May, will remain sound in the ground all summer while some other useful plant is growing on the field. In the fall they sprout and grow without requiring that the land be plowed. To make sure that seeds mature and drop to the ground, vetch should not be closely grazed after the middle

*From Sampson's Effective Farming*

FIG. 99. — CRIMSON CLOVER
Inoculating the seed of this legume will greatly increase the yield.

of April in the Gulf States. Vetch may be inoculated either with soil from a field of any kind of vetch or with soil from a spot where garden peas have grown. This is because vetch and garden peas are very closely related.

**Crimson clover.** — This is a plant (Fig. 99) with long heads of beautiful crimson flowers. It prevents leaching and loss of fertility in winter. It adds to the soil about as much nitrogen as does a crop of cowpeas. In the latter part of spring the richest kind of hay can be made from it. As soon as the hay is cut, corn or sorghum or sweet potatoes or other late crop may be planted to make use of the nitrogen which the clover roots and stubble have added to the soil.

FIG. 100. — ALFALFA

Crimson clover is very easy to grow. Land that has just grown cotton does not even need to be plowed. A little more than a peck of seed to the acre may be sown broadcast in the cotton in September and covered by passing a one-horse cultivator between each pair of rows. Crimson clover often fails if the land is not inoculated. To inoculate crimson clover, sow with the seed

soil from a field where crimson clover, red clover, low white clover, or other true clover has grown, or buy the pure cultures for inoculating clovers.

**Red clover.** — The blooms of this plant are pink, not red. Except in the extreme Southern and Western States this is the most widely grown legume. It lives for two years, the seed usually being sown in the spring or fall on growing wheat or grass, or alone. Red clover usually affords two or more cuttings the second year, sometimes even the first year on suitable soil in the extreme Southern States. It requires a good clay or loam soil and abundance of lime.

Fig. 101. — Southern Bur Clover
Note cluster of tubercles near parent "seed bur." Why here?

**White clover.**—This is a low plant with white blooms and white marks on the leaves. It lives for many years and its creeping stems take root at the joints. This makes it especially suitable for pasturage, which is its main use. White clover is also good for lawns. It is well suited to low damp land. The seed is sown in the early fall, usually in a mixture with pasture grasses.

**Alfalfa.** — This valuable plant (Fig. 100) is a cloverlike legume, the roots of which live for many years. Alfalfa

seed may be sown in the Cotton Belt either early in the fall or early in the spring. Three to five cuttings of hay can be made each year. It is, therefore, the most valuable of all forage plants for soils that suit it. Unfortunately it does not generally do well in most sandy soils in the Southern States. Sometimes fertile, loamy land will grow it well if the farmer can get rid of the seeds of crab grass and weeds and if he uses much lime besides manure or fertilizer. Favorite soils for alfalfa are the stiff, waxy lime lands in Alabama, Mississippi, and Texas, and stiff, rich, but well-drained river-bottom lands.

**Bur clover.** — This is an annual plant (Fig. 101) with yellow blooms. It is not a true clover but is close kin to alfalfa. It is used for pasturage and soil improvement. Unhulled seed pods (burs) of the Southern variety are sown about the first of September, the burs carrying sufficient dust from the field where they grew to inoculate the young plants. California bur clover seed is usually hulled and generally requires inoculation. It is earlier and less able to withstand the coldest winters than is the Southern bur clover. There are black spots on the leaves of the Southern species, and none on those of the California bur clover.

### Practice Work and Questions

1. Bring to school, if possible, seeds and leaves of cowpeas, soybeans, and velvet beans. In your notebook tell how these differ in size, shape, and otherwise, using drawings or words.

2. Bring to school for examination in class the leaves and blooms of as many as you can find of the following: any kind of vetch; red, white, and crimson clovers; alfalfa and bur clover.

3. If specimens are found, note on the leaves of each the following marks: the pale white marking of red clover; the narrower, distinct white marking on white clovers; the dark line on some of the leaves of crimson clover; and the black spots on bur clover foliage.

## CHAPTER XXVIII

## ROTATION OF CROPS

Rotation means change of crops in some regular order. It has been found that if one kind of plants is grown year after year on the same land, the yield decreases. If a different crop, the cowpea, for example, comes in between two cotton or two wheat crops, the yield of the cotton or wheat

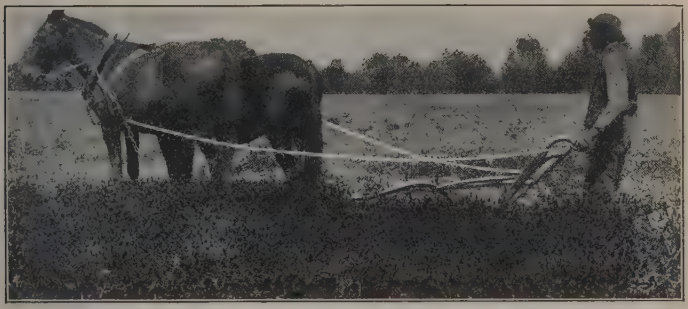


Fig. 102. — Plowing Under Crimson Clover in Alabama

is greatly increased. The different crops ought not only "to take time about" on any one field but should follow each other in a somewhat definite order. Some reasons for rotation are given in this chapter.

**Rotation to add vegetable matter.** — No soil can be kept fertile unless vegetable matter is added to it, either by the

decay of large amounts of plants grown on the land or by other means. Place must be made in any rotation for an occasional crop that leaves much vegetable matter to be plowed under or pastured. Hay plants almost completely cover the surface and leave a mass of roots and fallen leaves. The stubble of wheat or oats, together with the growth of weeds that usually follows these grains, also affords considerable vegetable matter.

**Rotation to add nitrogen.** — Plants like cowpeas and clovers obtain nitrogen from the air. This nitrogen is added to the soil when the growth of cowpeas or clover is plowed into the land (Fig. 102). Hence a wisely planned rotation makes room for the growing, as frequently as can well be done, of some leguminous crop, such as cowpeas, clover, peanuts, or velvet beans. When oats or wheat is grown, cowpeas or other legume ought usually to be sown just after the grain crop is removed. Velvet beans, cowpeas, or soy beans should usually be planted among the growing corn plants to improve the soil.

**Rotation to get rid of weeds.** — A cornfield generally contains more grass and weeds than a cotton field, because the cultivation of the corn is usually stopped earlier in the summer, thus giving weeds a chance to spring up. Cotton is cultivated so late into the summer that in the fall a well-kept cotton field is nearly clean. If a field produces several crops of oats or wheat in succession, it becomes very weedy. The wise farmer will grow on that field one or two crops of cotton or of some other plant that he cultivates very thoroughly in order to get rid of the weeds.

**Rotation to avoid diseases and insect pests.** — Every cultivated plant has its own special diseases and insect enemies that do not attack most other farm crops. Many

kinds of disease germs and insects remain alive in the soil for one or more years, ready to do injury when the proper plant is grown on that field. If the plants that would be attacked by these pests are kept away from that field for a few years, all or most of the germs or insects die of starvation. If, however, the plant subject to attack is soon put on the same land again, the pest increases and does more and more harm.

**Distributing labor and risk.** — Another reason for rotating crops is to diversify the farm products. The farmer who grows several crops has his labor better distributed over the entire year than the one who grows only one or two crops and is less injured if bad weather or low prices decrease his profit on one crop.

**Principles in planning rotations.** — Rotations must vary with the kind of crops to be grown and with the number of acres needed of each. Some of the principles to be observed in planning rotations are the following:

(1) Keep as large a proportion as possible of the land covered in winter with growing plants, since live roots take up and hold the nitrogen that would be leached from bare soils.

(2) Grow as many crops of legumes as practicable during the rotation period.

(3) Grow the main crops and legumes on any field in such order as to starve out the insect enemies and disease germs that attack some of them.

**Examples of rotation.** — (1) In those parts of the Cotton Belt where the cowpea continues to be the favorite legume, a good rotation is the following:

*First year:* corn with cowpeas between and oats sown in the fall;

*Second year:* oats followed by cowpeas;

*Third year:* cotton with crimson clover seed harrowed in between the rows early in the fall.

(2) Where the Mexican bean beetle (Fig. 169) becomes too destructive for its favorite food plant, the cowpea, to be grown, a rotation may be practiced in which this legume is omitted and the velvet bean and peanut substituted. One such three-year rotation is shown in the following diagram:

| | FIRST YEAR | SECOND YEAR | THIRD YEAR |
|---|---|---|---|
| Field No. 1. | Corn with velvet beans between. | Cotton; sow oats in the fall. | Oats (or other small grain); in June plant Spanish peanuts. |
| Field No. 2. | Cotton; sow oats in the fall. | Oats (or other small grain); in June plant Spanish peanuts. | Corn with velvet beans between. |
| Field No. 3. | Oats (or other small grain); in June plant Spanish peanuts. | Corn with velvet beans between. | Cotton; sow oats in the fall. |

On part or all of the field assigned to cotton in the diagram, sweet potatoes, sugar cane, or other hoed crop may be substituted. More nitrogen will be added to the soil by sowing a mixture of oats and crimson clover or oats and vetch where the diagram places oats and by grazing the mixture instead of harvesting it.

(3) The amount of June plowing required may be greatly reduced and the amount of pasturage greatly increased by substituting Lespedeza (see p. 160) for peanuts grown after oats. In this case the Lespedeza seed is sown in early spring on the growing grain and harrowed in lightly so as not to injure the oats. Since Lespedeza readily reseeds

the land, it should be allowed to grow the second year; thus the rotation period would be extended to four years, as shown below:

| FIRST YEAR | SECOND YEAR | THIRD YEAR | FOURTH YEAR |
|---|---|---|---|
| Corn with velvet beans. | Cotton; sow oats in the fall. | Oats and Lespedeza. | Lespedeza. |

(4) In the region just north of the Cotton Belt a satisfactory rotation is:

*First year:* wheat, in which red clover or grass seeds are sown;

*Second year:* clover or timothy hay;

*Third year:* corn (after clover or timothy hay);

*Fourth year:* corn or wheat.

### Practice Work and Questions

1. What farm or garden crops that are extensively grown in your neighborhood leave the field most free from weeds? Which one permits weeds to grow? Can the corn crop be harvested in time for wheat or fall oats to be sown?

2. In the three-year rotation of Example 1, what fraction of the cultivated land is occupied each year (*a*) by corn? (*b*) by cotton? (*c*) by oats?

3. Compare all the rotations mentioned and select the one you think best suited to your locality. Can you suggest a change that will make it better suited to the farm that you know best?

4. **Home project.** If you would be a prize winner in any contest for the largest yield on a "club acre" or "club plot," you should begin planning a long time ahead. Is there still time to make the land richer by growing first a legume to be plowed as a fertilizer for your prize crop of corn, wheat, or sweet potatoes? Chapter XXVI tells more about some of the legumes suitable for soil improvement.

## CHAPTER XXIX

## THE MAKING OF PASTURES—GRASSES

More and better pastures and live stock are greatly needed in the Cotton Belt. By proper management pastures can be made to pay both in the value of the live stock grown and in the improvement of the soil.

**Mixtures of forage plants.** — In pastures legumes are needed both to furnish protein to the animals and nitrogen to the soil for its improvement. They should be kinds that endure close grazing, such as Lespedeza and white clover. In permanent pastures there is also need for perennial grasses, that is, for those that grow from the roots year after year.

In a good pasture there should be a mixture of grazing plants. This is partly because some kinds furnish their grazing chiefly in hot weather, while others are at their best during the cooler months. In a good pasture in the Cotton Belt there may be Bermuda grass and Lespedeza for grazing in hot weather and white clover and other winter-growing legumes and grasses for grazing in late winter and in spring. In good pastures just north of the Cotton Belt we find blue grass, timothy, orchard grass, redtop and other grasses, together with white, alsike, or red clover.

**Preparation and care of pastures.** — Pastures pay well for good care. Preparation for starting a good pasture should be as thorough as for the planting of some cultivated

crop. To make a good pasture the careful farmer starts a year or two ahead and adds nitrogen to the soil by growing a leguminous plant, such as the velvet bean. He then plows the land and harrows it until the clods are crushed, for grass and clover seed are too small to come up from under clods. He covers the tiny seeds with as little soil as possible or leaves them to be covered by rain or snow. Often he manures or fertilizes the pasture land just as he does his cultivated fields. Even after the grasses grow, he spreads manure or litter on the poorer spots and, if necessary, scatters more seed there. He does not let robber plants make use of the soil fertility or moisture needed by grazing plants. Hence he mows the weeds whenever they appear in his pasture and before they can produce seed.

FIG. 103. — BERMUDA GRASS

**Bermuda grass.** — Some farmers fear to introduce this grass (Fig. 103) because it is difficult to destroy. There

will seldom be any desire to get rid of it if pastures are started in the right location. With Bermuda grass may be mixed Japan clover for summer grazing and either bur clover or vetch for winter grazing. Another excellent grass for pasture is carpet grass, which is not difficult to destroy. The seed may be saved from plants on the low spots in old pastures, where this grass often grows wild. It is best suited to sandy soils in the southern part of the Cotton Belt and in Florida.

FIG. 104. — SUDAN GRASS

**Sudan grass.** — This is an annual summer grass having stems, leaves, and seed heads like Johnson grass. Unlike the roots of the latter, those of Sudan grass die completely in winter and consequently this plant never becomes a weed. It is used chiefly for hay.

**Sorghum.** — This annual plant will grow on almost any soil. It is useful for green forage or for hay and for making

sirup. The seed must be sown thick to make good hay. Sorghum endures drought better than most annual grasses. It greatly exhausts the soil and hence should generally be followed by a legume.

Kafir, or kafir corn, is a kind of sorghum without sweet juice. It is used in Oklahoma and Texas both as a grain crop and for forage. It endures drought better than corn, and hence in dry climates it largely takes the place of corn. Kafir for grain is planted in rows wide enough to permit cultivation.

Other kinds of sorghum that are most valuable for grain in dry climates are milo and feterita, and a number of others. In moist climates the grain sorghums are kept from making large crops of seed by a tiny insect, called the sorghum midge, which destroys the seed before maturity.

### Practice Work and Questions

1. Collect seed heads of such of the grasses named below as are commonly grown near your home, and write in your notebook the season when each matures seeds; redtop or herd's grass, crab grass, orchard grass, and Johnson grass.

2. Dig plants of Bermuda grass to note whether it develops roots at the joints of the stems. Are the runners by which it spreads chiefly above or below the surface of the ground?

3. Search old lawns and low spots in old pastures for white clover. Does it form roots at the joints? Is such a plant more likely to continue to live in a closely grazed pasture than are those which do not form roots at the joints of the stems?

4. Search in pastures and old lawns for other clovers besides white. Perhaps you will find several wild clovers useful for grazing.

In high school or college you can learn much more about all the grazing plants mentioned in this book and about many others.

5. **Home project.** Are you going to raise a pig or a calf and will you make your own pasture for your pet? Then start the pasture before you get the animal. Talk to your parents about the best time for this and about the forage plants best suited to your needs.

## CHAPTER XXX

## WEEDS

A weed is simply a plant growing where it is not wanted. Hence plants useful in some fields may be weeds in other fields because they interfere with the growth of some crop. Among the plants that are sometimes weeds and at other times useful are Bermuda, Johnson, and crab grass.

Fig. 105. — Mullein

**How weeds injure the farmer.** — Weeds are injurious because (1) they use plant food and fertilizer needed by the more valuable crops; (2) they rob the cultivated plants of water by taking up the moisture of the soil for their own use; (3) they greatly increase the expense of cultivating the crops. Weeds are robber plants and must not be allowed to become large and strong, for then the crop will be ruined. Poor farmers cultivate their crops only whenever weeds become large; but good farmers cultivate the ground while weeds are still small, and whenever a crust begins to form. Some weeds are poisonous to live stock. Poison ivy severely irritates the skin of most persons.

**Study the habits of weeds.** — To get rid of weeds in the easiest and cheapest way, study their habits. First make sure whether they are annuals. If they are annuals, such as crab grass, foxtail, ragweed, bitterweed, and mullein, all that

Fig. 106. — Some Common Weeds
Beginning on left are two kinds of coffeeweed; cypress weed; goldenrod; and smartweed.

has to be done is to keep them from maturing seed (see Figs. 105, 106, 107).

**Fighting perennial weeds.** — Perennial weeds are those of which the roots live for several years. Common examples are "nut grass," dock (Fig. 108), Johnson grass, poison ivy, wild garlic (Fig. 109), red sorrel (Fig. 110), horse-nettle

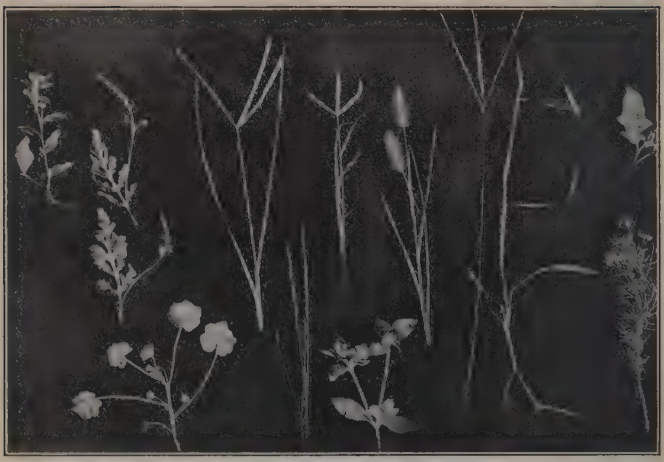


FIG. 107. — SOME COMMON WEEDS

Beginning on left are sida, ragweed, and mallow; 5 weedy grasses, including (on right) foxtail and crab grass; horse nettle (above); bitterweed (below); in the center, below, is Florida purslane.

FIG. 108. — DOCK

(Fig. 111), and morning-glory (Fig. 112). To kill perennial weeds, their roots must be destroyed. Plowing with a sharp plow often kills them. Another method consists in cutting off the stems just below the surface of the ground at frequent intervals. This prevents the leaves from making sap needed for keeping the plant alive. Hence in time the starved roots die. Weeds are sometimes destroyed by placing around their roots poisonous sub-

stances, such as arsenic, crude petroleum, kerosene, or gasoline.

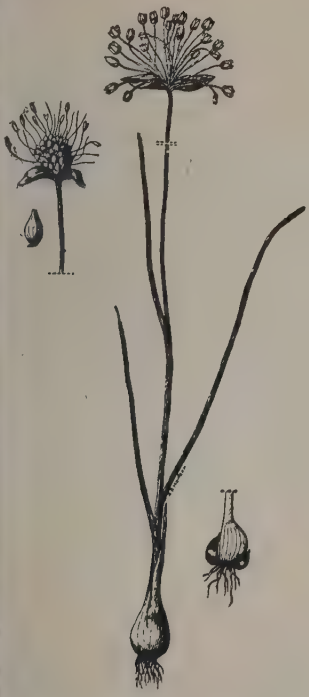


FIG. 109. — WILD GARLIC, COMMONLY CALLED WILD ONION

FIG. 110. — RED SORREL, A WEED OF SPRING

The weeds in pastures should be mowed. It may also be necessary to grub or dig in pastures such large plants as cypress weed and all kinds of bushes.

FIG. 111. — HORSE NETTLE, A PERENNIAL WEED OF SUMMER

FIG. 112. — THE TROUBLESOME MORNING-GLORY

**Smothering weeds.** — Sometimes the farmer can hire other plants to kill weeds. A crop of cowpeas or of velvet beans will sometimes smother Bermuda grass so that very little of it is left at the end of the season. The cowpeas or velvet beans kill the grass by shading it and by taking up the soil water which the grass needs.

**Keeping weeds off the farm.** — Good plowing and careful preparation may greatly reduce the number of weeds on the farm. However, their seed or those of worse weeds may be brought back mixed with purchased seed of grain, clover, or grass. Weed seeds are sure to be present in the cheaper grades of grass and clover seeds. It pays to buy the best of these in spite of their extra cost. A sharp watch should be kept for any

new weed so that it may be destroyed before it becomes widely spread.

*Courtesy of U. S. Department of Agriculture*

FIG. 113. — A CLUB MEMBER PREPARING FOR A CROP

## PRACTICE WORK AND QUESTIONS

1. Make in your notebook a list of (*a*) at least three weeds having seeds light enough to be scattered by wind; (*b*) at least two weeds of which the seed may be scattered by adhering to persons or animals.

2. Describe any other means by which weed seeds are scattered, and write the names of the weeds thus scattered.

3. Dig up some perennial weed and make a drawing of its roots in your notebook; also describe how it increases besides growing from seed.

## CHAPTER XXXI

## MULTIPLYING PLANTS WITHOUT SEEDS

Most field crops are increased or propagated by means of seeds. One plant, because of the seeds it forms, may become the parent of hundreds or of thousands of others of the same kind. This method of increasing plants is well understood.

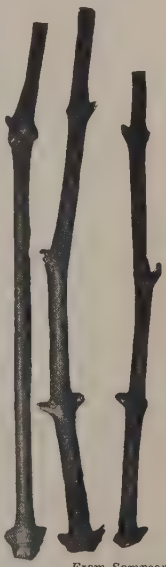
Most cultivated plants, including the perennials, develop from seeds. With most fruit trees and with many other plants, it is best to provide for the increase by budding, grafting, and the like. These and other methods of multiplying plants without the use of seeds are called *propagation by division.*

**Some plants propagated by buds.** — Did you ever see seeds on sugar cane or sweet potatoes? In the tropics these plants make seed, but not usually in our country. Therefore, we must find some other part of them that will grow. The part of the plant that can most nearly take the place of a seed is a bud. The sugar planter places long sugar canes in the ground, expecting the buds on them to grow. Likewise the gardener plants a piece of an Irish potato containing one or more eyes, or clusters of buds, but, if he so cuts the potato that one piece has no bud in it, no plant will grow from it and he will have a vacant hill.

**Most fruits do not "come true" from seed.** — One reason why the grower uses buds of sugar cane, sweet potatoes, and

seedless oranges is because he can not secure seeds to plant. There are advantages in using buds instead of seed in some cases even when the seed can be obtained easily.

By planting the seed of the peach we do not get peaches just like the one from which the seed came. The same is true with apples, pears, strawberries, and most of our fruits; they do not "come true" from the seed. However, the fruit on budded or grafted plants is like that of the tree on which the bud grew.



*From Sampson's Effective Farming*

FIG. 114. — SIMPLE CUTTINGS OF THE GRAPE

**Cuttings.** — Plants are increased either by planting seeds or buds. If, however, you should plant in the ground a detached bud from a grapevine or from a fruit tree, it would not grow. It would die (1) because a bud can not at first obtain any food from the soil and (2) because such a bud has not much food stored up to nourish it until it forms roots of its own. But you may so plant it that it will have much ready-made food convenient. Before the leaves start, cut off pieces of fig trees or grapevines of last year's growth six or eight inches long and containing at least three buds (Fig. 114). These pieces of stem or branch are called *cuttings*. Plant these in sandy soil, the upper bud just above the surface and the lower bud deep in the soil. If you have done this as a skillful gardener does, you will see after some weeks that the upper bud has begun to develop into a branch, which in time will be a real bearing grapevine. If you dig

up one of these little grape sticks that has thus begun to grow, you will find that tiny roots have formed. It was the food material stored in the stem or cutting that enabled the buds to grow.

The use of various kinds of cuttings is the usual way of increasing grapes, figs, poplars, and many other kinds of plants. The cuttings should have two or more joints. Grape cuttings usually have two or three buds. The usual time to put them in the ground is late winter. Under a cover of glass, and sometimes without this covering, many kinds of flowers can be increased by means of cuttings, for example, roses and geraniums. The chief use of the cover is to keep moisture in the leaf, the soil, and the air. After cuttings have formed roots, they are transplanted or set out in the place where they are to grow permanently.

**Runners.** — Do you know a plant that sets itself out? Does not the strawberry do so? Observe a runner or branch growing out of an old strawberry plant. When a runner takes root at its tip end, another strawberry plant begins growth.

**Growing strawberries for the family.** — Has any member of this class ever eaten all the strawberries that he or she desired? You can have strawberries for yourself and for the whole family as a daily treat in spring. The expense will be very little. Perhaps your parents will order a few hundred strawberry plants for you, or some neighbor may let you get the necessary plants from his strawberry bed. Plow and harrow the land thoroughly. Apply fine manure and complete commercial fertilizer (Chapter XVI), using about four times as much of either as farmers employ for their crops of cotton or wheat.

Set the plants about 18 inches apart in straight rows

about 3 feet apart. Strawberry plants may be set out at any time from October to March. If you set them in October and fertilize well, you should get a considerable crop of berries the next spring, but the main crop will come a year later.

Keep the plants free from winter-growing weeds until blooming begins. Then haul a load of pine straw or other leaves, and with these cover or mulch the ground. This mulch takes the place of cultivation, increases the yield, and keeps the berries clean. After the last picking cultivation should begin again, so that the plants may be kept clean and made strong enough to bear a big crop the next spring.

The following winter or early spring again apply fertilizer or manure. Some growers plant a new field of strawberries each year and plow up the old bed after it has borne one heavy crop. You will be able to take such good care of a small bed that it will bear good crops for several years. The largest berries are obtained by cutting off most of the runners, but if you keep your strawberry bed for several years you will need to let enough runners take root to furnish young plants each year, as these bear more fruit than old plants.

### Practice Work and Questions

1. In your notebook write a list of (*a*) ten kinds of useful annual plants; (*b*) ten kinds of useful perennials.

2. Make cuttings of grape, fig, willow, rose, geranium, or other plant. If possible, place these, as directed on page 181, in a box of coarse sand, kept constantly moist. After these are well rooted, would you not like to set out the plants at home or on the school ground? Possibly your parents or neighbors can show you the best way to make each kind of cutting take root. For example, sometimes a rose cutting is rooted by setting it in sandy soil and then keeping it moist and warm by covering it with an empty bottle or fruit jar placed upside down. (See Fig. 121.)

3. In agricultural papers for winter months find advertisements of nurserymen showing cost of 200 to 500 strawberry plants. If your parents are willing to buy them for you, let the order include at least two varieties, of which at least one is a perfect or staminate kind.

Whenever you set out the plants or give them other care, make a record in your notebook of what you do, and ask your teacher to let you tell the class about it each time.

4. If there is a nurseryman in your neighborhood, ask permission to visit him to get a lesson in plant propagation. Write in your notebook a complete story of your visit and what you learned from the nurseryman.

5. Make a fruit survey of the school district by taking a census of the number of apple, peach, cherry, plum, and pear trees; also an approximate census of small fruits.

## CHAPTER XXXII

## GROWING TOMATOES AND OTHER VEGETABLES

The products that a half-acre garden affords are usually worth more than those produced on several acres of common field. From a half acre of land a man whose business is gardening sometimes sells enough vegetables to bring him $100 to $200 or more.

**Care of the garden.** — To make a garden productive, treat it as follows:

(1) Manure it heavily, using twenty to forty wagonloads of compost or manure to an acre each year. (2) Keep every part of it busy, growing two or three crops a year on the same rows. (3) Plant such vegetables as will furnish something for the table every week in the year. (4) Plow the garden deep in the late fall or winter and keep it always so clean that a crop of rank weeds and weed seeds will not need to be plowed under. The garden will pay well for all the manure put on it. Vegetables are more tender and better, as well as earlier and more abundant, when grown on rich land.

**Planting seed.** — In planting garden seed, cover the large seeds, like beans and peas, with several inches of earth. The small seeds must be covered very lightly. Seeds will not readily germinate in rather dry, loose soil unless it be pressed

closely against them, so that it may bring up moisture, just as a wick brings oil to the lamp flame. Many gardeners tread on nearly every seed they plant, walking on the open drill on top of the seeds. The ground must not be too wet when packed. Loose soil should then cover the packed ground.

*From Watts' Vegetable Projects*

FIG. 115. — AN EARLY CROP OF VEGETABLES IN COLDFRAMES

This loose layer of soil keeps the moisture from rising above the seeds and evaporating.

**How to set a young plant.** — IN transplanting tomatoes or other young plants, avoid doubling the roots. If the ground is so dry that the young plants must be watered when transplanted, first punch the hole; next insert the plant; then pour in a cupful of water, which will settle the soil snugly around the roots. Last and most important of

all, draw up loose, drier soil around the plant and over the wet spot. Every time a young plant is watered, the wet

FIG. 116. — TOMATOES OF FLORIDA CLUB GIRLS PRAISED BY THE HOME DEMONSTRATION AGENT

spot should afterwards be covered with loose, dry soil to hold the moisture and to keep a crust from forming. When rather large plants are transplanted, it is best to pinch off

some of the leaves so that they may not evaporate water faster than the broken roots can supply it.

**A succession of vegetables.** — A little work and planning every week are worth more to a garden than twice as much work every two weeks. By thus planning it is possible to have vegetables every week in the year. Most well-cultivated gardens in the Southern States afford an abundance of vegetables during May, June, and July. To be sure of a continuous supply through August, September, and October, make late plantings of tomatoes, butter beans, okra, corn, eggplant, and other vegetables that thrive in hot weather.

*Courtesy of Kentucky Agricultural Experiment Station*

FIG. 117. — TOMATO PLANT PRUNED TO ONE STEM AND STAKED

The period when fresh vegetables are scarce is from November to March. During this time there should be a stored-up supply of sweet potatoes, fall-grown Irish potatoes, cushaws, pumpkins, dried beans, dried sliced okra, and rutabaga turnips. Fresh vegetables can also be secured

during most of this time by planting in July, August, or September seeds of collards, cabbages, rutabagas, beets, beans, and turnips. The planting of onion sets in the autumn and the sowing of seed of kale and spinach for winter "greens" should not be forgotten. Salsify is a delicious vegetable available for fall use.

**Hotbed or coldframe.** — To obtain early vegetables a hotbed or coldframe will be helpful, because under this the young plants can be started during the winter. The frame is made as shown in Fig. 115. It has no bottom, but rests over a shallow pit into which a layer of damp manure has been placed and covered with several inches of soil. The purpose of this manure is to afford, by fermentation, heat to warm the soil in which the seeds are to be planted. Plant the seeds in drills a few inches apart. When the frame is placed over such a layer of heating manure, the whole is called a hotbed. A similar frame is called a coldframe if no manure is used under it. The cover usually consists of several glass sashes. On a coldframe the cover may be of white cloth.

FIG. 118. — PODS AND SEEDS OF BUTTER BEANS

To make a small hotbed or coldframe to be covered by a single sash construct a wooden frame 6 feet long and at least 3 feet wide. The back should be 12 inches high and the front 8 inches. It is better to make it at least 6 feet wide, thus requiring two sashes. The glass sashes slide on strips nailed to the sides or on crosspieces. The earth should be banked around the outside of the frame.

The slope of the glass sash should be towards the south. The sun's rays strike through the glass, which serves as a trap for the heat. In this heated air and soil young cabbages, tomatoes, and other plants grow rapidly. On mild days the glass must be lifted so as to prevent disease and to accustom the plants to cool weather. A box kept near a window indoors or covered with panes of glass may take the place of a coldframe.

**Growing tomatoes.** — Seed may be planted in shallow boxes of soil kept in a sunny window or on a south porch. This should be done a number of weeks before the time for transplanting. The seed are planted ¼ to ½ inch deep in rows 2 inches apart, or in the same way in a coldframe or hotbed. When the plants are about two inches high, they should be transplanted to other boxes or to another part of the coldframe, at distances of about 2½ inches. Still earlier and stronger plants may be made by transplanting the young plants to small paper or earthen pots. After danger of frost is past, the plants, now grown larger, are transplanted to the garden. To avoid breaking the roots and checking growth by transplanting, the soil of the box or coldframe is moistened and cut into squares by a sharp knife passed midway between the plants so that each plant may be set out with a block of soil about its roots.

By pruning and staking tomato plants (Fig. 117), the crop is made earlier and the fruit larger. For this purpose

stakes about five feet long are driven close to each plant. All stems are cut off except one or two, and these are carefully tied to the stake. Once a week the grower should pinch off the sprouts or suckers that grow from the angle between the stem and leaf.

The county home demonstration agent can probably furnish more complete printed instructions for growing tomatoes, or pupils may write to the State Agricultural College for pamphlets telling how to grow and can tomatoes.

**Vegetables that may be planted in cool weather.** — Among the plants of the garden that can endure rather cold weather are the pea, kale, mustard, radish, spinach, and lettuce. The seeds are, therefore, usually the first to be planted, in February or earlier. Young cabbage plants endure much cold. In the central part of the Gulf States they often live through the winter when set on the south side of a ridge or bed. Irish potatoes are planted while the weather is still cold.

Among the vegetables that are not killed by slight frosts are beets. Onions are very hardy. Sets are placed in the ground in the fall, or in January or February. Some varieties of onions grow well from seeds planted in the fall or late winter, the young plants being afterwards transplanted. Garden peas are planted three or four inches deep, usually in January, February, and March.

**Tender vegetables.** — Among the plants easily killed by frost are beans, tomatoes, eggplants, squashes, and all the other members of the gourd or melon family. These can not safely show above ground until danger of frost is past; so they are usually planted about the same time as the earliest cotton. Tomatoes are usually started under glass and transplanted as soon as the danger of frost is past.

**Vegetables that suffer from hot weather.** — Peas and lettuces do not thrive during hot weather. Cabbages and turnips are usually ruined by the harlequin cabbage bug and by other insects after midsummer; they should, therefore, be grown either as very early crops or in the fall.

### Practice Work and Questions

1. Write the names of all plants the leaves of which you know to be cooked for "greens." During what months can each one be used?

2. Make a list of all the vegetables you have ever seen growing in your home garden.

3. The pupils in schools that have gardens enjoy working on their little plots. Would you like to help in making a school garden? If so, tell your teacher. In a school garden each member of the class in agriculture who does not work a part of the garden at home has about a square rod of land and plants in it seeds of vegetables that are ready for use before school closes, such as the radish, lettuce, onion, carrot, kale, pea, beet, turnip, mustard, and spinach. The school garden should also include a collection of flowers.

4. This lesson affords an opportunity for the members of canning clubs and for other pupils to discuss their experiences in growing tomatoes, beans, and other vegetables.

5. Practice setting young plants according to directions on pages 186 and 187.

A good experiment for the class is to set some large plants without removing any of the leaves and others with the leaf surface properly reduced. Observe which ones show least wilting if left without watering.

6. **Home project.** Every member of a class in agriculture should grow at home some vegetables or some field crop. If you have not such a patch, tell your parents that you wish to work a part of the garden. There you can try out the things that you learn about agriculture at school and elsewhere and can often bring to the class specimens and reports on the plants you grow.

If you are not already a member of a boys' or girls' agricultural club, ask your teacher whether one may be organized.

## CHAPTER XXXIII

## GROWING FLOWERS

Most of the plants in the flower garden may be classed either as (1) shrubs, (2) bulbs and tubers, or (3) herbs. All the shrubs are perennial and so are most of the plants grown from bulbs and tubers. Flowering herbs may be either annual, biennial, or perennial. As a rule perennial plants furnish the earliest flowers, for they have laid up in their roots, stems, or bulbs a supply of food intended to hasten the growth of the new flowers.

Fig. 119. — Chinese Abelia

**Shrubs.** — Most cultivated shrubs can be increased by means of cuttings or by suckers from the old roots. Shrubs require less care than smaller plants and endure for many years. Among the first of the shrubs to burst into bloom in the spring are the snowball and the bridal wreath.

Among the most easily grown ornamental shrubs are the hedge plants, Amoor River privet and Chinese abelia; pink crape myrtle; the purple wistaria, and the common honeysuckle, both vigorous climbing plants

suitable for screening unsightly objects; the pomegranate, prized for its red blooms and fruit and for its attractive foliage; the hydrangea, which bears immense clusters of blue, white, or pink flowers; and numerous classes of roses.

Many of the native or wild shrubs and trees are beautiful in foliage or flower or fruit and are easily transplanted from the woods to the home grounds. Among these are dogwood, the wild white hydrangea, the elder, the holly, and the redbud, which is prized because it is covered so early in spring with a mass of pink flowers. The expense of adorning the home grounds need be but slight where one relies chiefly on transplanting wild shrubs and trees and on planting seeds of the common flowers.

FIG. 120. — HYDRANGEA

Shrubs, trees, and other large ornamental plants lend most beauty to the home when they are clustered in groups or massed against fences or buildings, leaving free the central part of the lawn.

**Propagating roses.** — Roses are grown from cuttings, which are started either out of doors or under glass, depending on the kind of rose, the climate, and the soil. On these points you will need the advice of those neighbors who grow roses. Where practicable to start your rose out of doors

proceed as follows: In the autumn take a portion of a slender rose branch less than one year old on which the wood has recently become firm. Cut this six to eight inches long and remove the leaves. Be sure that a smooth cut is made.

If the cuttings are to be started in moist sand under glass, they may be much shorter and of younger wood. Part of the upper leaf may be left. Place the longer cuttings in a sloping position in a trench in the flower garden and cover them up to the top bud with earth. Where the winters are cold a thin layer of leaves may be added. Roots may form in four to six weeks. When one year old or less, the plants may be transplanted to the place where they are to remain. Roses like good soil, and the ground around them ought each year to receive a coating of manure which serves as fertilizer and mulch. On sour soils a little lime is helpful.

Fig. 121. — A Rose Cutting under a Fruit Jar

A rose cutting is sometimes started into growth by setting it about halfway in sandy soil out of doors and over it placing a fruit jar or an empty bottle turned upside down (Fig. 121). This holds the heat and moisture and serves as a tiny greenhouse.

**Chinese abelia.** — Few ornamental shrubs combine as many desirable qualities as the Chinese abelia. It is valued for the long period through which each year it continues to produce an abundance of pinkish-white flowers; for retaining its glossy foliage throughout the winter in the Cotton Belt; for its hardiness and freedom from attacks of

insects or plant diseases; and for the ease with which it can be propagated from cuttings (Fig. 119).

**Bulbs and tubers.** — The onion and lily are examples of bulbs. A bulb consists of a number of thickened tightly wrapped leaves. Bulbs that grow form new bulbs, and by planting these the plant is multiplied. Plants grown from bulbs need rich soil. Jonquils, narcissuses, tulips, and many other bulbs are planted in the fall. Year after year their bright colors are among the first heralds of spring.

FIG. 122. — FLOWER AND SEED BALL OF HOLLYHOCK (SINGLE)

The canna affords a wealth of blooms — red, pink, yellow, and other gay colors — during the heat of summer. It is increased by planting portions of the roots. In the same way gardeners multiply the dahlia, which is prized for its succession of large, bright flowers throughout the summer. Violets for winter and early spring and hardy chrysanthemums for late fall flowering are increased by dividing the roots of old clusters of plants.

**Early flowers from seed.** — Most of these are annual plants, living less than one year. Some are longer-lived, for example, the foxglove, the hollyhock, and the larkspur. Sweet peas may be planted while the weather is still cold.

The California poppy is fine-leaved and has large, brilliant flowers. The seeds of this plant and also of the

common poppies are sown as soon as danger of severe freezes is past. At the same time the seeds of pinks or carnations are sown.

The sweet William is closely related to the pink. The flowers are showy and beautiful. The plant is rather hardy with reference to heat.

The annual phloxes are among the best flowers for children to grow, because they afford such a mass of varied and bright colors so soon after the seeds are sown in early spring. They need good soil and abundance of water.

Fig. 123. — Petunia (on Left) and Cosmos (on Right)

The pansy and indeed many of the very early annuals may be sown in the fall in boxes indoors and soon transplanted to rich soil. Here the plants grow all winter ready to begin blooming early in the spring. Sweet peas also are planted in the fall, as are larkspur, cornflowers or ragged robins, gaillardias, and many other plants that the florist calls half-hardy. By sowing seed of such half-hardy flowers in the fall wherever the winters permit, the plants come into bloom earlier.

Verbenas are the favorite flowers of many children and of many grown persons as well. They grow either from seeds or cuttings. There are few more beautiful sights in

the flower garden than a border thickly bedecked with the purple and crimson or other varied colors of the verbena.

**Summer flowers.** — Among other plants grown from seed that may be relied on for blossoming in summer are zinnias, larkspurs, four-o'clocks, hollyhocks, petunias, and many members of the sunflower family. The seeds of petunias are so small that, like many other flower seeds, they need either the shallowest possible covering or none. A good way to plant such seeds is to sow them and then with a board press them against the surface; sprinkle over them the thinnest possible layer of very fine sifted forest soil. This holds moisture and does not easily form a crust.

**Fall flowers.** — The marigold and cosmos can endure heat. Their blooms are wanted in late summer and fall after most flowers have ceased blooming. Scarlet sage is also one of the most brilliant of the summer and autumn flowers, its tall stems being crowded with bright red blooms.

**Window gardens.** — Many persons who have not room for an outdoor flower garden find pleasure in a little window garden. The flowers may be grown in pots or boxes, inside a sunny window or on a shelf outside a window. Most of the smaller outdoor flowering plants may be thus grown from seeds, bulbs, roots, and cuttings, and, in addition, many less hardy plants, such as the begonia, crab cactus, and geranium. To start geraniums or other soft-wood cuttings, place the lower portions of the cuttings in clean sand kept moist in a sunny window. If necessary, a pane of glass can be placed over them to retain the heat and thus make a tiny greenhouse.

### Practice Work and Questions

1. Ask some grower of flowers whether the present is a suitable time to start cuttings of roses and other flowers. If so, make some cuttings and set them.

2. Ask at home or at some neighbor's whether there is any flower from which you can get a start of bulbs, roots, or cuttings. Before using them make sure they are free from disease or insect injury.

3. Write in your notebook a list of five of your favorite flowers.

4. **A flower show.** What fun it would be for any visitor at school on the day you study this chapter to find the school decorated as for a flower show! Why not have one? You can do so if this lesson is studied or reviewed when flower gardens are gayest with color. Let each pupil bring to school for the next part of this Practice Work as many kinds of flowers as possible. This collection will determine whether you can hold a real flower show.

5. **A flower game.** Let the pupil who brings in the greatest number of different flowers label each kind brought by any pupil with the numbers 1, 2, 3, 4, etc. Pass each numbered flower slowly to each member of the class or school (for all may join in this game). Let each one write in a notebook the names of all the flowers that he recognizes, each opposite its number. Who wins this one point by recognizing the largest number?

While the blooms are being numbered, let another member of the class label a separated leaf of each kind, giving each a number, and making sure of the name of the flower from which each leaf came. As before, let each pupil guess the name. As this is more difficult, shall the winner, who has the longest correct list, score two points? Let others who correctly guessed more than half of the names of leaves score one point.

Next let the leader hold up one kind after another of bloom and leaf, with a number for each. Let each pupil opposite that number write in his list the word "annual" or "perennial," according to the plant's length of life. This, too, is hard enough to entitle the winner with the longest correct list to score two points and to give one point to each one who answers correctly for more than half of the plants shown.

## CHAPTER XXXIV

## GRAFTING AND BUDDING FRUIT TREES

In an earlier chapter we learned that, in order for fruit trees to resemble the parent tree, they must be multiplied by means of buds instead of by the use of seeds. Unlike a seed, a bud is not planted directly in the soil. Instead it must be kept in contact with enough wood and bark to furnish it with a supply of ready-made food. The most common methods of multiplying fruit trees are budding and grafting.

Fig. 124. — Whip Grafting
Showing how small stocks are grafted.

You can learn how to bud and graft fruit trees and roses if you will study the pictures and directions and will practice a little every day for a week or two. By budding or grafting the poorer varieties in your parents' orchards with the buds or twigs from the best variety in some neighbor's orchard, you will be of real help at home and will probably be able to enjoy some of the improved fruit yourself.

**Directions for grafting.** — Grafting consists in making a short piece of twig of one plant unite with the branch or root of another. The plant that furnishes the twig (called a *cion*) must be very closely akin to the plant upon whose

branch or root the cion is to grow. The plant or piece from which the roots spring is called the *stock*. Generally stocks are common young plants that have been grown from seed. Usually the cion is a short piece of twig about one year old and bearing two or three buds. The stock may be a young stem, piece of root, or a young or an old branch. Grafting is generally done in the late winter or very early in spring while the plant is resting.

Fig. 125. — Method of Grafting Large Branches

In Fig. 124 is shown one way of cutting the cions and the stocks in grafting apple cions on small branches or small pieces of apple root. Your knife must be sharp and thin, so as not to split the cion or stock in making the slit. After cutting the two pieces as shown in the figure, place their ends together, making the two slender tongues lock. The important point is to make sure that on one side the *bark* of the two pieces comes together evenly. The union is caused by the cambium just under the bark of the cion growing against the similar layer in the stock. *These growing layers must touch on at least one side of the graft.* In setting in the ground cions that have been grafted on

Fig. 126. — An Apple Tree with Top Renewed by Grafting

roots, the joint or union is placed below the surface.

**Grafting on large branches.** — When a small cion is grafted on a branch that is one or two inches through, the limb is cut off square, then slightly split (Fig. 125). In this slit is placed the sharpened cion, which is cut tapering from *both* sides. The bark of the young cion must join evenly with the bark on one side of the large split limb. To make sure that the two barks are pressed together tightly, the wedge part of the cion is left a little thicker on the outside, that is, on the edge that is going to join the bark of the large branch. In all kinds of grafts, drying must be prevented by covering the cut portions with grafting wax. Usually a graft on a small stock is tied with a cloth string and then waxed. Fig. 126 shows a new top made by grafting.

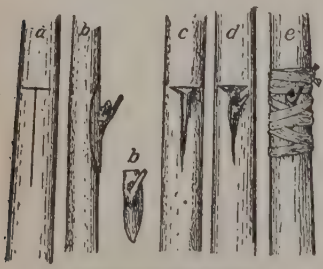



FIG. 127. — BUDDING
*a*, showing the slit; *b*, *b*, the bud; *c*, the slit opened; *d*, the bud in position; *e*, method of tying.

**Budding.** — This process consists in inserting a single bud, with a tiny strip of attached bark, just under the bark of a growing shoot. The bud should be cut out with a slender piece of bark and wood about three fourths of an inch long, leaving a part of the leaf stem for use as a handle. This is the way in which peach and many other fruit trees are increased. Budding is usually done in summer while the plants are in active growth. To serve as stock for budding, an apple tree may be about two years old, but a peach seedling can be budded in its first year of growth.

Two slits in the shape of a **T** are cut in the stock, as shown in Fig. 127. The bark below the cross slit is gently lifted and the bud placed under these two flaps of bark and tied in place. In a few weeks, when the bud has united with the stock, the strings should be cut. Next spring the top of the stock above the inserted bud should be cut off, so as to let the inserted bud become the leading branch of the tree.

### Practice Work and Questions

1. Collect twigs of persimmon or wild cherry about as large as a pencil. Study Fig. 124 and practice making the cuts and close unions shown there by grafting together short sections of any of these twigs. See which pupil can show the teacher the graft in which there is the most even pressing together of the inner bark of the stock and cion and the neatest and tightest locking of the cut surfaces.

2. After getting some practice in cutting and making grafts of worthless twigs, ask your parents or some neighbor to let you try real grafting on apple shoots. The time to do grafting is in winter. Cut the cions from a tree that bears the best kind of fruit and insert them on small twigs or limbs of a tree that bears inferior fruit. It is still better to buy from a nurseryman a small number of cions of the variety desired or that he recommends.

To make the grafting wax needed, melt together 8 ounces of resin, 4 ounces of beeswax, and 2 ounces of tallow or linseed oil. When heated, pour the mixture into cold water, grease your hands and "pull" it as you would molasses candy.

3. Examine twigs of a peach tree. Observe that there are two classes of buds. From the plumper buds flowers and fruit develop. The slenderer buds are the leaf buds.

Are the flower buds of the peach tree borne chiefly on twigs grown during the past season or on older wood?

## CHAPTER XXXV

## GROWING AND PRUNING FRUIT TREES

It is possible to have a constant succession of fruit at very little expense by taking the best care of a few rows of strawberries, an arbor of grapes, and a small orchard of fruit trees. In the collection of fruits there could be strawberries, raspberries, grapes, scuppernong grapes, peaches, plums, apples (Fig. 128), pears, Japanese persimmons, pomegranates, and pecans. It costs but little to buy the trees and other plants needed. Make selections from the catalogues of reliable nurserymen not too far away.

For success in fruit growing there must be (1) wise selection of suitable varieties, (2) careful planting, (3) regular and intelligent pruning, (4) cultivation and fertilization, and (5) spraying to destroy injurious insects and plant diseases. A small orchard for home use should contain a number of varieties so that there may be early, medium, and late fruit.

**Cultivation and fertilization.** - Before planting fruit trees the land must be deeply plowed and well harrowed. Peach trees are generally set fully 16 feet apart each way and apple trees 25 to 40 feet. On rather poor land fruit trees ought to be fertilized when set and each year afterward. For young trees a complete fertilizer is best. In later years a mixture of phosphate and some form of potash may be sufficient. Nitrogen should then be supplied

Fig. 128. — Harvesting Apples in Arkansas

by cowpeas or some other "catch crop" grown as a fertilizer between the trees. Scatter the fertilizer as far out as the limbs extend and work it in with a cultivator or harrow. For a few years a low-growing cultivated crop, for example, cotton or vegetables, may be grown between the rows of

Fig. 129. — Students Learning to Pack Fruit

trees. When, however, the trees get larger, they need all the space; and the orchard should be kept well cultivated until July, when Iron cowpeas may be sown as a fertilizing crop to be plowed under the next spring.

**When a fruit tree is old enough to transplant.** — A nurseryman does not count the age of a tree from the time

the seed is planted, but from the time of budding or grafting it. Peach trees are ready to transplant one year after the budding has been done. The apple tree is transplanted when either one, two, or three years old.

FIG. 130. — CLOSE PRUNING

**Setting a fruit tree.** — The time to set a fruit tree is after the leaves fall and before the buds swell in the spring to form new leaves. The period from November to February is the usual time for setting fruit trees in the Southern States. The holes should be so dug that the roots will not need to be bent. All bruised or broken roots should be cut off with a smooth cut, for this heals more quickly than a ragged break. The very long roots may be cut back. In setting trees, keep all roots straight. The earth taken from near the top of the hole is generally the richest, so this soil should be placed near the roots. The earth must be firmly packed around the roots so as to keep them thoroughly moist. The upper layer of soil must be left loose as a mulch to retain the water in the lower layers. If a tree is loosened before it has formed a full set of roots, it is likely to die because the shaking causes air spaces to be left around the roots instead of moist soil. The tree ought to be set in the ground at least as deep as it grew in the nursery row.

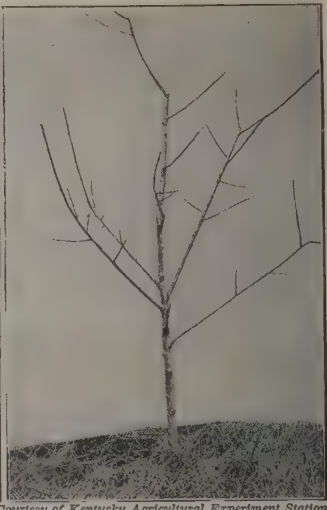
FIG. 131. — STUB PRUNING

FIG. 132. — ONE YEAR AFTER SETTING

To be pruned as shown by the marks.

**Pruning at the time of transplanting.** — When a young tree is dug up, a large propor-

tion of its fine roots and root hairs is broken or stripped off. When it is transplanted, there will not be at first enough feeding roots to supply food and water to all the leaves. The top of the tree should, therefore, be cut back to balance the loss of roots. The cutting off of some of the limbs is called



*Courtesy of Kentucky Agricultural Experiment Station*

FIG. 133. — PEACH TREE, TWO YEARS OLD, BEFORE PRUNING

FIG. 134. — SAME PEACH TREE AFTER PRUNING

pruning. Most fruit trees at the time of transplanting have to be severely pruned in order (1) to keep the leaf surface balanced with the feeding roots and (2) to cause the tree to grow in the desired shape.

**Shaping the young tree.** — When young apple and peach trees are not pruned, the central shoot grows more rapidly

than the side branches. This forms a tall, slender tree with few limbs, and these bend and break when heavily loaded with fruit. Much of the fruit on unpruned trees is borne too high to be easily gathered. To prevent these troubles the young apple or peach tree is cut off at a height of 16 to 24

*Courtesy of Virginia Extension Service*

FIG. 135. — APPLE TREE, EIGHT YEARS OLD, BEFORE PRUNING

FIG. 136. — SAME APPLE TREE AFTER PRUNING

inches above the ground. The cutting of the central shoot makes the side branches grow more rapidly and nearer to the ground. The lower limbs should be close to the ground in order to shade the body or trunk.

If the tree is very young and small when transplanted, all the side branches are also cut off close to the main stem

(Fig. 130). The buds near the top of this stub or whip will soon grow out and take the places of the side branches that were cut off. The number of limbs can be controlled by rubbing off all the buds except the number desired. In pruning a young tree, three, four, or five of these buds should be allowed to grow into limbs. The buds selected to grow should be evenly distributed around the stem. If

FIG. 137. — POOR PRUNING

FIG. 138. — GOOD PRUNING

the young tree is well-grown when transplanted, its branches are cut off 6 to 8 inches from the main stem (Fig. 131).

**Later pruning.** — After the transplanted trees have been growing for about one year in the orchard, they usually need to be pruned again. All the three, four, or five side branches already selected for growth should be cut back until only about 8 to 12 inches of their new growth is left (Fig. 132). At the end of each year the new peach twigs, if they have made much growth, will need to be cut back to about half of their length (Figs. 133, 134). Every winter cut out from

any fruit tree all the branches that are partly broken, too close together or growing across the center of the tree, and all twigs that are diseased.

The later pruning of trees is chiefly (1) to regulate the shape, (2) to make the center of the tree open enough to admit the light, and (3) to thin the fruit. Wherever a branch is removed, the cut surface must be left smooth and as close to the parent branch as possible. No projection or stub must be left. A smooth close wound is soon healed and covered over; but a stub is not easily covered, and decay starts in the wound (Figs. 137, 138). When a large branch is cut off, the wound should be covered with thick white-lead paint to keep the germs of decay from entering the tree.

Fig. 139. — Pruning to Direct Growth

On right, pruned for upward growth; on left, pruned for outward growth.

In pruning a fruit tree the bud left farthest out on the branch is the one that will grow most rapidly and become the leader. The limbs can be made to bend upward or downward more than they naturally would by making the cut just beyond a bud which points in the desired direction (Fig. 139).

**Fruits that most need pruning.** — Peach trees, grapevines, raspberries, and cultivated blackberries need pruning every year. Apple trees require less after the first few years (Figs. 135, 136), and shade and nut trees require very little pruning.

## CHAPTER XXXVI

## TREES FOR SHADE AND TIMBER

The true value of trees is scarcely realized until we consider the sufferings of people who live in countries that are almost without trees. Parts of India, Egypt, China, and Korea are in such a treeless condition. In winter the people suffer intensely from cold and have to work very hard to supply themselves with even a little fuel. A day's hard work may be rewarded with only a basket of the roots of shrubs. Every bit of refuse in the streets and stables is collected and dried for fuel.

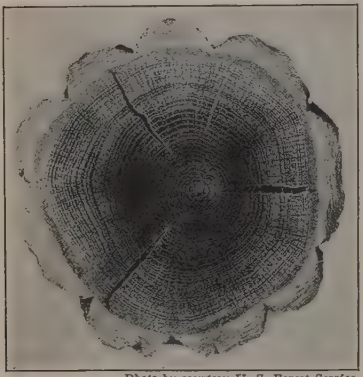


*Photo by courtesy U. S. Forest Service*

FIG. 140. — CROSS SECTION OF A LOG WITH ANNULAR RINGS

**Rapid destruction of the forests.** — Our own country is in danger of a lack of trees to furnish lumber for the homes and factories of the future. The tree lives longer than any other form of vegetable life. It is the patriarch among plants. The life of a young tree ought not to be taken except for good cause. The farmer who

makes firewood out of saplings is destroying the property of his children.

**Telling the age of a tree.** — The age of a tree may be

*Photo by courtesy U. S. Forest Service*

FIG. 141. — YOUNG SOUTH CAROLINA LONG-LEAF PINES
The sets of branches indicate the age of the top.

discovered by examining the log or the stump left after it has been felled. On the smoothly cut end of the log there are a number of light-colored rings with layers of darker color between (Fig. 140). Generally one light-colored ring

and one dark-colored layer were formed each year. The number of light rings tells in years the age of that part of the body of the tree. The age of each limb is told in the same way. The number of sets of branches tells the age of the tops of some trees (Fig. 141).

*Photo by courtesy U. S. Forest Service*

FIG. 142. — RESULT OF FIRE AND WIND ON FOREST IN LONG-LEAF PINE, CUBAN, AND SOME LOBLOLLY PINE, HAMPTON COUNTY, SOUTH CAROLINA

**Uses of forests.** — Forests not only furnish lumber, material for paper and scores of useful articles, but they decrease floods. When rain falls on the soil of a forest that has never been burnt over, it sinks into the mellow soil and slowly drains away to the creeks, which carry off the water

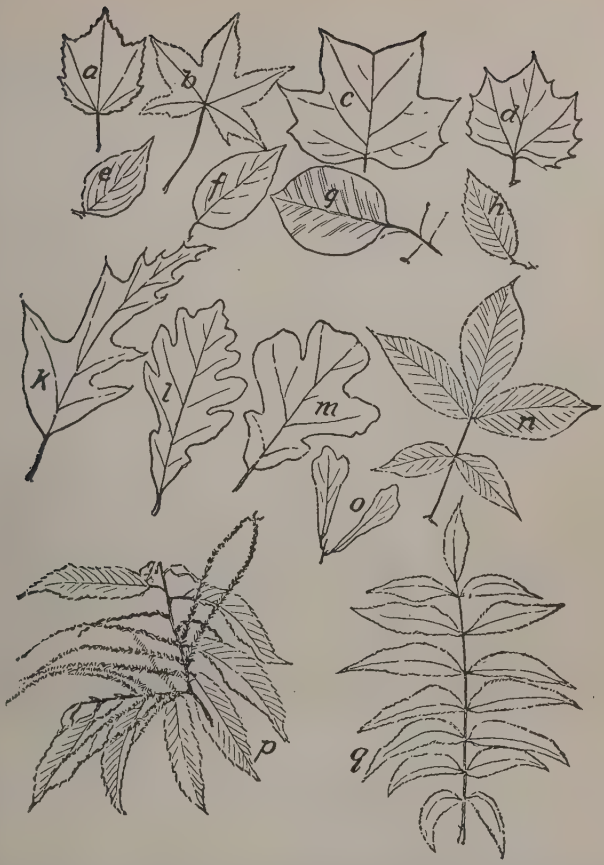



Fig. 143. — Find in the Above Figures the Following Leaves
White oak, hickory, pecan, red oak, black gum, sweet gum, chinquepin, water oak, sycamore, maple, "yellow poplar" (tulip tree), dogwood, elm, persimmon, post oak.

without overflowing. When the trees are cut, the surface loses its layer of leaves and becomes hard so that, when heavy rains occur, the water rushes rapidly down the slope, washes sand and soil into the creeks, and overflows the bottom lands.

**Forest fires.** — The long-leaf or yellow pine tree may be six years old before it becomes one foot high. A single fire, started by some careless hunter or some thoughtless person "to burn off the grass," may kill a thousand of these and other trees of valuable kinds on every acre that it invades (Fig. 142). Besides this fires make the soil of the forest poorer by destroying the vegetable matter and thus retard the growth of the surviving trees.

**Helping to save the forests.** — We may some day need to renew the forests by extensive planting of trees. If we act promptly, we may use less expensive methods. Chief of these are the prevention of fires, the leaving of an occasional mature pine as a "seed tree," and the cutting of only the nearly mature trees. Wherever there is need for shading or beautifying the home or for insuring a supply of posts, trees should be planted. Trees suitable for planting to produce fence posts are catalpa, black locust, mulberry, and osage orange. Posts made from these trees last for a long time. Inferior kinds may be used for posts if first stripped of bark, dried, and treated with creosote.

**Planting shade trees.** — If the home or the school needs shade, trees should be set. We may choose some of the following: the water, or willow-leaved, oak as a round-topped shade tree, suited even to poor, dry soils; the sweet gum, for its rapid growth, graceful shape, its willingness to grow on almost any soil, and for its red and purple leaves in autumn; the mulberry for its rapid growth, good shade, and sweet fruits; the elm for its rapid growth, great size,

and graceful shape; the hackberry for its ability to grow on stiff, wet soils; the black gum for its thick rounded top and its beautiful red leaves in autumn; and the red maple for its red flowers and seeds and its brightly colored leaves in the fall. These trees and many other kinds may add greatly to the comfort and beauty of the home and may so change the school yard that it will become one of the most attractive spots in the neighborhood.

**The trees as friends.** — To obtain all the pleasure possible out of life in the country, you should know and love the trees. Know them by their leaves (Fig. 143), their branches, their barks, and their seeds. Notice which kinds are found on the dry hills and which in the wet bottoms. Observe how they struggle up toward the light. Notice the difference in the forms of those that stand alone flooded with sunshine and those starved for light in the deep shadow of the crowded forest. Even in winter the trees are interesting. Then they may be recognized in the distance by the differences in their habits of branching. For example, notice the continuous central stem in the pine and hickory and observe that in the walnut and elm this is usually absent.

### Practice Work and Questions

1. Do your parents think that the woodland on the home farm will perpetually furnish a supply of good posts and necessary fuel? Estimate whether the same is also true for most farms in the neighborhood.
2. Find and record the age and diameter of two recently cut logs or stumps by counting the annual rings.
3. Compare the leaves in Fig. 143 with leaves found in the woods, and write in your notebook the name that corresponds to each letter.

## CHAPTER XXXVII

## CAUSES OF DISEASES OF PLANTS — GRAIN DISEASES

Most plants have a green color and thrive in the light. Certain very small plants, called fungi, however, have no green color. Among them are the tiny organisms that cause rotting of fruit, spotting and dying of leaves, rust, and smut of grain. Since these have no green substance enabling them to use the carbon from the air, they can not make their own living. Instead they draw their nourishment from the sap and substances already made by green plants. Therefore they rob the plants on which they grow and cause various diseases [1] which may affect the leaves, stems, or fruits of useful plants.

**Molds.** — Among the fungi are certain molds. Fruit mold or bread mold is made up of a mass of fine white threads, some of the short branches of which bear tiny black heads. These contain the spores, dustlike bodies from which another crop of fungi grows. Spores are to fungi what seeds are to plants. The spores of mold and of most fungi are so small and light that they are blown everywhere by the wind. This explains why plant diseases are so "catching," or contagious.

Some fungi can not grow through the skin of fruits, but

[1] The chapters on plant diseases were written by Dr. B. M. Duggar of the faculty of Washington University.

need to have their spores planted in cuts or bruises. Other kinds are able to force their way through the skin. Very often they push in through the "gateways" or pores in the leaves of plants. Once inside the fruit or leaf, they grow and nourish themselves by absorbing the food material formed

Fig. 144. — A Spraying Machine Doing Efficient Work

by the green plant. They steal the food which the plant had prepared for its own use.

**Killing fungi with poisons.** — Fortunately the spores of most kinds of plant diseases will not grow in contact with certain substances (Fig. 144). Two of the most effective chemicals used to destroy fungus spores are bluestone (copper sulfate) and formalin. The buds, fruit, or leaves are

sprayed with a mixture containing bluestone. If this is done before the fungus has passed through the skin of the fruit, the crop is often saved. The poison generally used to ward off diseases of fruit trees, potatoes, and certain other plants is Bordeaux mixture, which contains bluestone (see Appendix).

**How diseases of plants are spread.** — Most diseases are carried to healthy plants by the light spores, which correspond to seed. These spores are smaller than particles of

*Courtesy of U. S. Department of Agriculture*

FIG. 145. — SOUND POTATOES (in center) FROM TREATED "SEED"; SCABBY POTATOES (on both sides) FROM SEED POTATOES NOT TREATED

dust and are transported long distances by the wind. Disease germs are also carried to healthy plants by insects.

**Prevention of plant diseases easier than cure.** — In most cases, however, it is useless to try to cure diseases by treatment after the fungi have entered the green plant, where no poisons can reach them. Spraying of fruit trees and other plants is done to prevent and not to cure diseases.

**Weak plants become diseased.** — Plants that are thrifty and well nourished are less likely to catch certain diseases

than those that are weak, starved, or unwisely fertilized. Some diseases of plants, however, are not due to germs. These are usually due to poor drainage or other unfavorable conditions of soil or climate. Such diseases are not contagious.

**Oat smut.** — In a field of ripening oats we often find some blackened, smutty heads (Fig. 146). The black dust which flies when these are touched consists of spores, whose only function is to cause more smut in next year's crop. They do this by blowing to healthy oat grains during ripening or while the crop is being threshed. Such grains do not themselves become unhealthy, but when planted they sprout and then permit the entrance into the tender young plant of the germs that will cause its seeds to be smutted.

*From Livingston's Field Crop Production*

FIG. 146. — CONCEALED AND LOOSE SMUT OF OATS

Would you not like to keep smut entirely out of all the oats grown on the home farm? You can do this by killing the germs of smut on the seed oats with formalin. Thoroughly wet the seed in water to which one ounce of formalin has been added for every three gallons of water. Keep the treated seed moist and covered with cloth for several hours, so that gases from the formalin may be sure to kill the smut spores. This treatment costs only a few cents for each acre planted and may add from two to ten bushels to the yield of oats on every

acre. There are some other diseases that may be prevented by poisoning the spores on the seeds.

**Concealed smut of wheat.** — In one form of wheat smut the disease is not readily observed but is covered by the seed coats, or kernel coverings. On crushing one of the diseased kernels, the spores will be found and the unpleasant odor that arises will not be forgotten. This form of wheat smut may be prevented by soaking the seed in a solution of bluestone.

**Rusts.** — The leaves and stems of oats, wheat, rye, and barley are attacked by rusts. No treatment has been found to prevent the rusts of grain. Some varieties are more injured by rust than others. Those that ripen early oftenest escape severe injury.

### Practice Work and Questions

1. Search for mold on stored sweet potatoes or on old bread, and note the threads of the fungi and their tiny balls of spores.

2. When wheat or oats have formed heads, count the numbers of smutted and healthy heads on a square foot or square yard of surface. From these figures estimate how much the yield will probably be reduced by smut. Find on small plants of wheat, oats, or rye the discolored spots caused by rust.

3. **Home project.** If you study this lesson near the time for planting oats, offer to prevent smut in the oats of your parents or of some neighbor by treating the seed as directed on page 221.

## CHAPTER XXXVIII

## SOME DISEASES OF FRUITS

Rotted peaches and apples are usually due to definite diseases. Most kinds of fungi that cause spotting or rotting of the fruit also make the tree unhealthy by attacking the leaves or twigs or trunk. When these fungi grow on the twigs or trunk, they are especially likely to live through the winter and thus to get an early start in spoiling the leaves or fruits the next season. Hence the first spraying of the trees each year should be before the leaves come out, for a stronger poison may be employed then than is safe for the foliage.

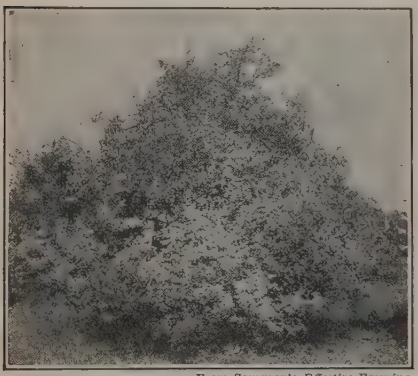
*From Sampson's Effective Farming*

FIG. 147. — MUMMIES OF BROWN ROT OF THE PEACH

**Combined spraying against both fungi and insects.** — It is usually possible to kill both injurious fungi and insects

at the same time. This can be done by adding arsenate of lead to the poison intended to destroy the germs of plant diseases.

**Brown rot of peaches.** — One day a brown spot may appear on a peach, and the next the whole fruit may be browned and decayed. Meantime there may appear on the surface numerous gray tufts of the moldlike fungous spores. These light spores are carried by wind and insects to healthy fruits which then rot.



*From Sampson's Effective Farming*

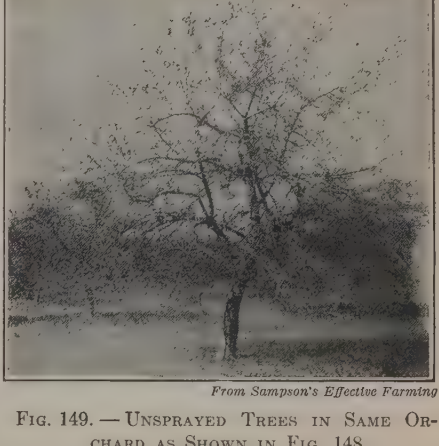
FIG. 148. — SPRAYED TREES IN SAME ORCHARD AS SHOWN IN FIG. 149

With age a diseased fruit shrivels and becomes what is termed a "mummy." These mummies hang on the tree and there the fungus remains until the next season ready then to start a new outbreak of the disease. In controlling this malady, therefore, first remove and destroy or cover up by plowing all mummied fruits. Then spray the trees with Bordeaux mixture *before the buds open* to kill all germs.

The leaves of the peach tree are easily injured by a strong spray. Therefore for the sprayings after the leaves come out the fruit grower uses a weak mixture called "self-boiled lime-sulfur." This is just strong enough to destroy the germs of the disease without injuring the tender leaves.

The spread of brown rot is largely due to the curculio. You will learn (p. 261) that the eggs of this insect hatch into the worms that you find in wormy peaches. While laying their eggs these insects also "plant" under the skin of the little green peach the spores that produce brown rot. Therefore, the fruit grower adds to the spray material mentioned above a little arsenate of lead to destroy the insects before they lay their eggs. (See Appendix.)

**Peach leaf curl.** — This disease may be recognized by the curling and arching of the leaves, which later turn dark and fall. The fruit shrivels and becomes almost worthless. The young shoots also may become diseased. The fungus establishes itself at the time the fruit buds are opening. It may be prevented by spraying the trees with Bordeaux mixture just before the buds open (Figs. 148, 149).



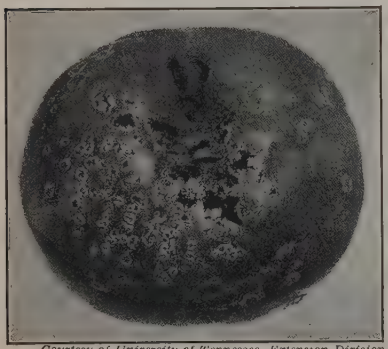
*From Sampson's Effective Farming*

FIG. 149. — UNSPRAYED TREES IN SAME ORCHARD AS SHOWN IN FIG. 148

**Apple scab.** — This disease is very common throughout the country in moist seasons. Examine the fruit carefully during July and August, and the presence of this disease will be shown by the scabby spots that do not resemble rot (Fig. 150). There is an olive-colored growth around these.

Scabby spots may also occur on the leaves. The apple scab causes an enormous loss, making the apples misshaped and dwarfed and often reducing their selling price by half. When the scab begins, it may kill the bloom or it may cause the little apples to fall. In ordinary seasons this disease is well controlled by spraying at intervals of two weeks with Bordeaux mixture.

**Bitter rot of the apple.** — As the name implies, an apple attacked by this disease has a bitter taste. Bitter rot is worst in moist, warm weather. It begins as a small spot and rapidly spreads from fruit to fruit. Later the affected area becomes flattened or sunken. A few days after the rot has begun, little circles of black dots appear at the center of the diseased spot. These little dots contain the spores which will spread the disease. This fungus also makes injuries, called *cankers*, on the branches of the apple tree.



*Courtesy of University of Tennessee, Extension Division*

FIG. 150. — APPLE SCAB

It is estimated that bitter rot of apples has repeatedly caused damage to the extent of ten million dollars a year. It may be controlled by the use of Bordeaux mixture.

**Fire blight of pear and apple trees.** — The common blight of pear and apple trees, which kills and blackens the leaves and sometimes kills the pear tree, is caused by

germs, called *bacteria*. This disease also kills the blossoms. The germ is carried by bees and other insects from a diseased tree to a healthy flower of pear or apple. The fungus grows into the flower and on into the twigs, causing them to die. Pear blight, unlike most diseases, does least harm to trees that are growing slowly and thus forming tough, short twigs. Hence, when a grown pear tree is attacked, cultivation may be stopped, and no fertilizer rich in nitrogen should then be used.

Spraying is not a cure, but cutting away in winter and throughout the growing season all the diseased twigs helps to control the disease. Cut the twigs about one foot below the diseased portion. After making each cut kill any germs that may have lodged on the blade of the pruning shears or knife. Do this by dipping the blade into a solution of formalin or of carbolic acid or by wiping it on a cloth dampened in some poisonous solution. Thus you will avoid spreading the disease.

### Practice Work and Questions

1. Find, examine, and show to your classmates specimens of peach "mummies," rotting peaches or plums, diseased apples, curled peach leaves, or spotted leaves of any fruit tree. Do the appearances suggest that you are looking at the diseases here described?

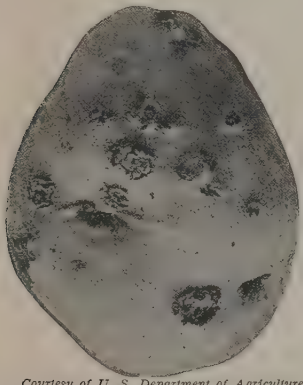
2. Did apple trees drop many of their leaves before frost last season? Were there any spots on such leaves? The spots and shedding of leaves may have been due to scab, bitter rot, or orange-colored leaf rust.

3. Most State Experiment Stations will identify diseased leaves or other specimens addressed to their botanists and will furnish bulletins on plant diseases or tell you where to get the bulletins that you may desire.

## CHAPTER XXXIX

## DISEASES OF TOMATOES AND POTATOES

Tomatoes, Irish potatoes, and sweet potatoes are injured by a number of diseases. Many of these can be controlled by spraying with Bordeaux mixture or by treating the seed with formalin or other poison.



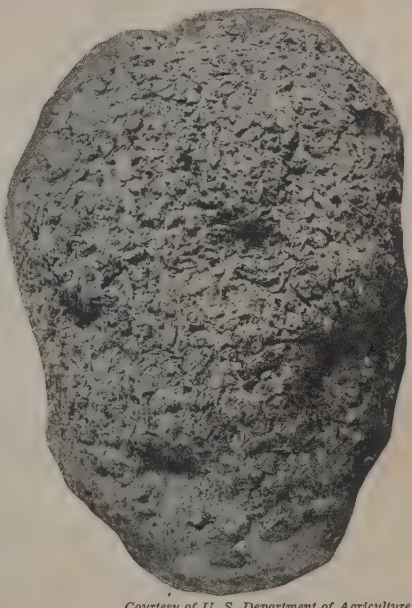
*Courtesy of U. S. Department of Agriculture*

FIG. 151. — A MILD CASE OF SCAB
Diseased seed potatoes should be treated.

**The scab of Irish potatoes.** — Irish potatoes often have surfaces covered with rough scabs (Figs. 151, 152). This is a fungous disease. If a scabby potato is planted, both fungus and potato are sown, and the harvest will consist of both. Moreover, the fungus spores are likely to be present in a soil which has recently produced scabby potatoes, ready to injure the next crop. Fortunately this disease is easily prevented. A sound crop comes from smooth, healthy potatoes in a soil where scabby ones have never grown. For safety treat seed potatoes by soaking them two hours in a formalin solution containing one ounce of formalin to two gallons of water.

**The early blight.** — This common disease of the leaves of the Irish potato is indicated by round brown spots which appear upon the leaves or by irregular spots on the margins. This disease is readily prevented by spraying the foliage with Bordeaux mixture. Paris green may be added to the mixture so as to poison the potato beetle at the same time.

**Some leaf diseases of tomatoes.** — When tomatoes are attacked by the early blight, small brown or black spots appear on the leaves and sometimes also on the fruit. It can be controlled by spraying the entire surface of the plants about every ten days with Bordeaux mixture. The same spraying is also useful against other leaf diseases of tomatoes, as *leaf spot* and *mildew*.



*Courtesy of U. S. Department of Agriculture*

FIG. 152. — A SEVERE CASE OF SCAB
Ground producing such potatoes should be planted to a different crop.

**The soft rot of sweet potatoes.** — Sweet potatoes in storage are sometimes injured by the same black mold that may often be found on bread or on preserves. When the potatoes are stored where it is too moist and warm, this

fungus grows upon them and produces what is known as the soft rot, which has an unpleasant odor. This fungus takes advantage of the so-called sweating period, which occurs a short time after the sweet potatoes are dug. It then finds an easy entrance through the injuries on the sur-

*Courtesy of Indiana Extension Service*

FIG. 153. — TOMATO WILT; LEAF AND SECTION THROUGH STEM
Note dark areas in stem.

face or through the broken end of the root. From a single diseased or bruised spot it may spread with alarming rapidity. This disease is readily prevented by proper drying of the potatoes for a few days after they are dug, before placing them in the lower temperature at which they are to to be stored. Infected potatoes should be destroyed.

**Black rot of sweet potatoes.** — This disease is indicated by roundish black patches on the potatoes. If such potatoes are placed in the seed bed in spring, the sprouts, or slips, that grow will catch the disease. Hence any slips that show the slightest black spot near the base of the young stem should be burned as this disease would later kill or injure such plants and cause any potatoes that might be produced from them to rot.

The best means of preventing various diseases of sweet potatoes are to avoid bruising the potatoes as they are dug and to plant in the seed bed only sound individuals. Some growers are careful to make new seed beds each year and also to soak the "seed" sweet potatoes for ten minutes in a solution of 1 part corrosive sublimate to 1000 parts of water.

**Wilt diseases of many crop plants.** — There are distinct wilt diseases that destroy the plants of tomatoes (Fig. 153), Irish potatoes, sweet potatoes, cotton, cowpeas, and other plants. The germs causing these diseases pass from the soil into the roots and stems and plug the water-carrying vessels. Thus they cause the plant suddenly to wilt and die. In plants suffering from wilt diseases the stems when cut across show dark threads or specks.

Since the threads of the fungus are inside the root and stem, the wilt diseases can not be controlled by spraying. They are spread chiefly by the germs that remain in the soil on pieces of old diseased plants. The fungus may remain alive in the soil for several years and start the disease anew whenever the same plant or a near relative is again grown there. Hence the means of avoiding the wilt diseases consist in (1) burning the old diseased plants and (2) employing rotations that permit these crops to be grown not oftener than once in three or four years. We must be sure also

that the seed bed for such plants as tomatoes has not before produced diseased plants.

Fortunately plant breeders have developed varieties of tomatoes, cotton, cowpeas, and watermelons that are not easily injured by wilt diseases.

### Practice Work and Questions

1. Examine Irish potatoes to see whether you can find the rough, dark spots that result from scab.

2. Examine stored sweet potatoes and try to determine whether any dark spots present resemble black rot; they may be merely bruises or signs of some less serious disease.

3. Write in your notebook a list of all the diseases mentioned in this chapter that you think you have observed.

4. **Home project.** Inquire whether there are fruit trees or vegetables at home or anywhere else in the community that are to be sprayed. If so, the owner will doubtless be glad to have the help of any members of the class in agriculture in getting ready and applying his spray materials.

You could even make up a small amount of Bordeaux mixture at home or in partnership with the other members of the class by following the directions given in the Appendix.

## CHAPTER XL

## DISEASES OF COTTON

From some spot long used as a garden, carefully dig plants of tomato or okra. Do you find enlargements or knots on the roots? If so, they show that these plants and most other vegetables or cotton grown in that location will be seriously injured.

FIG. 154. — ROOT KNOT ON COTTON PLANT, CAUSED BY EELWORMS (NEMATODES)

**Root knot.**—Harmful knots may occur on the roots of cotton (Fig. 154), tomatoes, most other vegetables, peach trees, most varieties of cowpeas, and great numbers of other plants.

Root knot can not be prevented by spraying or by treating the seed. You will understand why it can not be controlled by poisons when you learn that it is caused by tiny

worms which are able to live in the soil a long time. Therefore, we must fight this disease by starving the worms. This is done by keeping away from any infested field all those kinds of crop plants and weeds on the roots of which the worms can feed and multiply. Hence a wise rotation of crops is doubly important where this disease occurs, as it does in garden spots and many fields, especially on the sandy soils in the southern part of the Cotton Belt.

*From Duggar's Southern Field Crops*

FIG. 155. — COTTON PLANTS ATTACKED BY WILT

**Cotton wilt.** — Cotton wilt, often called black root, causes the plant to drop its leaves or wilt and then dry up. Most plants die when bearing a full load of blooms and bolls. The disease occurs chiefly in the southern half of the Cotton Belt, and as far west as Louisiana. It is very common on certain of the islands on the South Atlantic coast where sea-island cotton is produced.

The first year that wilt occurs in a field it attacks only a single plant or small spots, here and there. The next year the spots where the plants die are larger. In a very

few years the fungus may become so very widespread as to make it impossible to maintain a stand of cotton on any part of the field (Fig. 155).

In the stem of a cotton plant that has been attacked by wilt, the woody portion is darkened or streaked with very fine black lines. These black lines are the water-carrying

FIG. 156. — DIAGONAL SECTION THROUGH COTTON STALKS
On right, healthy plant; on left, blackened by cotton wilt.

FIG. 157. — DIXIE, A WILT-RESISTANT VARIETY OF COTTON

vessels that have become stopped up by the growth of the fungi. Their stoppage causes the plant to wilt for lack of water. A dark layer occurs just under the bark (Fig. 156). The germs of the disease enter the plant through the roots. Cotton wilt is usually considerably worse on land where the tiny worms that produce knots on the roots are present.

The germs that cause wilt probably enter more readily through the wounds made by these worms on the roots of the plant.

**Wilt-resistant varieties.** — In diseased fields there may be a few stalks which do not contract the disease. If so, they are resistant and their seeds may transmit this natural resistance. Mark them and very carefully preserve their seeds for planting purposes. Some varieties of cotton

FIG. 158. — SOUTH CAROLINA FIELD OF WILT-RESISTANT DIXIE TRIUMPH COTTON

show marked differences in their ability to withstand the attacks of this fungus. The Dixie (Figs. 157, 158), Toole, some strains of Cook, and some varieties of sea-island cotton have been made quite resistant to cotton wilt by years of selection.

Rotation of crops is the usual way to decrease the damage from wilt. However, the germs of wilt live in the soil for several years. Hence, in a rotation for land where

this disease occurs, cotton should not be grown oftener than once in three or four years. Neither should the ordinary varieties of cowpeas be used in such a rotation, for the root-knot worms, if present, increase rapidly on the cowpea roots. This increases the number of wounds on the cotton roots the next year, and hence probably the number of wilt

FIG. 159. — BOLL ROT OF COTTON

*Photo by A. B. Shear*

FIG. 160. — ROOTS OF A COTTON PLANT ATTACKED BY ROOT ROT

fungi entering the cotton plant. In a rotation of crops on such a field, velvet beans and the Iron and Brabham cowpeas may well be grown, because the root-knot worms do not rapidly increase on the roots of these plants.

**Cotton-boll rot.** — In moist seasons this is a common disease (Fig. 159). It is most severe in moist bottom lands where the large plants shade the ground and the bolls.

The careful observer will notice first upon the boll small water-soaked spots, and, as these spots increase in size, they become gray at the center and finally pink with a purple border. The pink or gray coating is evidence of the abundant production of fungous spores. These spores are blown about or spread by insects, thus planting the disease wherever they fall upon cotton bolls surrounded by sufficient moisture and warmth to make the spores develop. The boll rots and the contents are ruined. Varieties differ somewhat in the extent to which they take the disease. The germs of this disease are carried to the new crop by seed from diseased bolls. Treatment of seed is not easy because the fungus is inside the seed coat. To decrease the disease, plant seed only from a field that was free from boll rot or from selected, healthy plants.

**Black rust.** — This is the disease that so generally causes the cotton plant gradually to drop its leaves. The leaves turn pale or yellow and then blacken and die. Black rust is not started by germs. After a plant has been made weak and unhealthy by unfavorable soil or other surroundings, the rust fungus enters the leaves and completes their destruction. Rust is largely a disease of poor land and can be prevented on some soils by adding vegetable matter or potash.

**Cotton-root rot.** — The farmers of Texas and Oklahoma are not troubled with cotton wilt. Instead, their cotton often suffers from another disease, which in appearance is very similar to the wilt. This is the well-known root rot, or "dying" of cotton. The symptoms of this disease also are sudden wilting followed by the death and browning of the whole stalk. Plants die about the time that the first bolls begin to open. It seems to be most common in the black waxy and other stiff soils.

The method of its attack is very different from that of the cotton wilt. Over the whole root system and particularly covering the larger roots are brownish-yellow threads, or a fuzzy growth of the fungus. The threads penetrate the bark and even extend into the wood of the roots; the younger roots are promptly killed (Fig. 160). Wilting is due to the failure of the roots to furnish the usual supply of water.

This fungus spends the winter on the live roots of certain weeds, such as the wild potato. Hence such weeds in infected fields should be killed by thorough plowing in fall or early winter. Increased circulation of air is believed to be helpful. This can be attained by deep plowing, thorough cultivation, and the addition of stable manure or vegetable matter. Rotation of crops is necessary. Such a rotation should not include alfalfa, sweet potatoes, or other plants on which this fungus can live. On land where cotton-root rot occurs, corn, the small grains, sorghum, the true grasses, and many other similar crops may be grown.

### Practice Work and Questions

1. Examine fields of cotton to see whether there are spots on which the very young or older plants have completely died. Ask your parents whether this was due to one of the diseases mentioned in this chapter.

2. Examine the roots of tomatoes or of cotton or of okra. If knots occur, they have been caused by tiny eelworms, also called nematodes. Find what other plants near by have the same kind of root knots. If you carry specimens of any kinds of diseased plants to school for the teacher and class to see, first wrap them very securely. Then after they have been examined in class, burn every bit of any infected specimen so that you may not cause any disease to spread to other plants.

3. Examine the roots of growing cowpeas, soy beans, vetch, or any kind of clover. You will probably find the helpful tubercles, or fertilizer factories, slightly attached to the root. On the same plants you may find the harmful root knot. You may know the latter by the swelling of the root all around or by the large size of the knots.

## CHAPTER XLI

## INSECT LIFE AND GROWTH

All insects[1] belong to the animal kingdom. They are, therefore, *animals*, of which class they form much the largest group. In fact there are more kinds of insects than of all other animals and plants put together.

**What an insect is.** — Most insects have wings when they are in the full-grown or *adult* stage, but some never have these in any stage of their existence. When wings are present, there may be either one or two pairs. Nearly all insects have legs; six is the usual number. Spiders, mites, and other small creatures that have eight legs are not really insects; neither are the true worms.

The body of a mature insect is divided into three parts: the *head*, the *thorax*, and the *abdomen* (Fig. 161). The head bears the *eyes*, the *antennæ*, or feelers, and the *mouth parts*. To the *thorax*, or chest, of the insect are attached the *wings* and the *legs*, but both wings and legs are entirely wanting in some insects.

**Eyes and antennæ.** — The eye is made up of a large number of simple eyes, so closely crowded together that they form what is called a *compound eye*. As a whole it is shaped somewhat like half a raspberry, dewberry, or blackberry. The shape of each part of the eye is something like that of a cell in a honeycomb.

[1] The chapters on insects were written by Dr. W. E. Hinds, Professor of Entomology in Alabama Polytechnic Institute.

The antennæ bear the *sense organs*, which correspond to our *touch*, *smell*, and probably *hearing* also. One reason why the name "feelers" is often applied to these organs is because the insects really seem to use them in that way. Insects do not have noses or ears as we have, but some of them have the sense of smell very wonderfully developed, and doubtless they hear many sounds that never reach our ears. There are many interesting differences in the form of the antennæ of the various insects.

FIG. 161. — THE PARTS OF AN INSECT

**Wings and legs.** — The wings serve to carry their owners over long distances. They are very important aids in enabling insects to find their food. A bee could not get enough to eat if it had no wings to carry it from flower to flower. The legs are arranged so as to balance the body in walking. Having six legs, the insect always has three on the ground while it is moving the other three forward.

One difference between the structure of insects and four-legged animals is that the insects have their skeletons or bones, as we may call them, on the outside of their bodies. This is what makes an insect hard. For this reason, insects can not grow slowly and steadily as do animals that have their skeletons inside and covered with the soft and easily stretched muscles and skin. When insects grow, they do so by sudden jumps, as it were. When they have grown so that they fill their outside skins very tightly, a new skeleton is formed inside of the old; the old skeleton bursts and is shed by the insect. Increase in size may occur while the new skeleton is yet soft.

**Immature and adult forms of insects.** — Among the insects that change but little with their development are the grasshoppers and the true bugs. Those who study insects use the name "bug" only for a certain large group, just as one would speak of the "flies," "bees," and "grasshoppers." Grasshoppers and bugs when young have the same general form of body as when fully grown, but acquire wings as they become adult. Most of the other common insects undergo amazing changes. It is important to know this, since it may be difficult to destroy an insect in one stage but easy to do

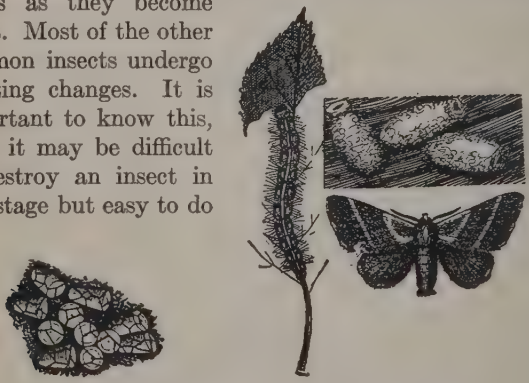


FIG. 162. — FOUR STAGES OF INSECT (TENT CATERPILLAR)
Eggs separated and magnified; larva; cocoon; moth.

so in another. Among those that make great changes in form are all of the *caterpillars*, which become butterflies or moths when full-grown; the *maggots*, which become flies; and *grubs*, which become beetles. You will find it exceedingly interesting to watch a caterpillar change its skin or the butterfly emerge from its *chrysalis* or pupal case.

**Stages in an insect's life.** — In the life of most insects there are four well-defined stages. The first is the *egg;* the

second, the *larva;* the third, the *pupa;* and the fourth stage, the *adult* (Fig. 162). With a few insects there is no visible egg stage, as the young are born alive. This is the case with plant lice. The larval stage is the growing period in every insect's life. If it is not well fed, the adult insect coming from it will be smaller in size than usual. The pupa, or *pupal stage,* occurs only among insects in which the form of the larva is very different from that of the adult. It is purely a *transformation stage* and is one of the most wonderful facts in the life of any animal.

**Transformation from caterpillar to butterfly.** — When the butterfly caterpillar has become fully grown, it ceases to feed and seeks some protected spot in which to change or transform. After a few days the caterpillar sheds its larval skin and becomes the pretty, shining *chrysalis,* or *pupal case,* of the butterfly. This is usually attached to some twig or stem. The surface is marked with delicate lines which really indicate the outlines of the *sheaths* within which the wings, legs, and antennæ are developing.

A new butterfly is formed out of the body of the old caterpillar without destroying its life. This is just what happens with most insects. With moths the changes are very similar, only they are hidden from view by the *cocoon,* or silken case, that the caterpillar spins around itself for protection during this critical time of life. The change with wasps and bees and bettles is just as great as with butterflies and moths.

### Practice Work and Questions

1. Catch a fly or other insect and find all of the parts of the body which have been mentioned. How many pairs of wings has it? If you can get a magnifying glass, examine the eye, antennæ, mouth, and feet. Describe what you see.

2. Bring some potato beetles to the school and confine them in a glass jar with some of the potato vine. Notice the eggs that may be laid. Have some earth in the bottom of the cage for the larvæ to enter when they are ready to transform. After a few days dig out some of the pupæ to see how differently they are formed from the mature insects that were put in. Or confine some other plant-eating insect with its food plant and later notice its eggs and whatever hatches from them.

3. Secure various kinds of insects from the garden, bringing them if possible on the plant on which they are feeding. Determine if you can whether they are harmful or beneficial insects.

4. Study the live specimens, noting in each case: (*a*) general appearance by which it may be identified; (*b*) nature of good or harm done; (*c*) stages in which they are harmful or beneficial; (*d*) kinds of mouth parts and method of eating; (*e*) means of locomotion.

## CHAPTER XLII

## INSECTS AND HEALTH

Some of the diseases most fatal to mankind are spread by insects. Among these are typhoid fever, malaria, and yellow fever. Every pupil in school can be helpful in preventing these diseases by carrying on a watchful warfare against flies and mosquitoes.

**Flies carry disease.** — Flies (Fig. 163) are very important agents in spreading typhoid fever. They do this by carrying to human foods on their feet or mouth parts the germs that cause this disease. These germs are brought from the infested matter which flies visit. The danger of the spread of

*Photo by W. E. Hinds*

FIG. 163. — THE HOUSE FLY
Eggs; larvæ or maggots; pupæ; adult.

such a disease by flies can be decreased as follows: (1) by frequent use of lime where needed about the premises so as to reduce the number of flies and thus protect food; (2) frequent cleaning of stables and lots to keep flies from breeding there; and (3) thorough screening of houses.

**Mosquitoes and yellow fever.** — It has been proved very positively that certain kinds of mosquitoes are agents in carrying yellow fever from one person to another. It is probable that it is spread in no other way. The carrier is the common black- and white-banded day mosquito.

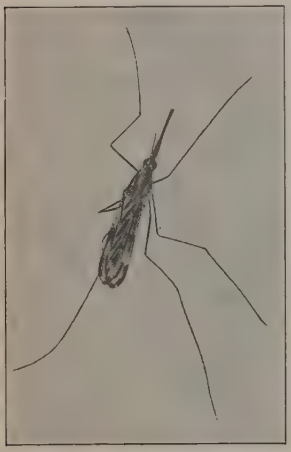


FIG. 164. — A MALARIA MOSQUITO

The victory over yellow fever has been won chiefly by preventing the breeding of mosquitoes and by the use of wire screens.

**How malaria is spread.** — Another class of mosquitoes is the only means of spreading malaria, or "chills and fever." Malaria is caused by a very minute animal that lives as a parasite in the red blood cells of man. When a mosquito sucks blood from a person who has the disease, the parasites are taken with the blood. In the body of the mosquito certain of them undergo a development which they never do in man. After about ten or twelve days in the mosquito these parasites pass through its stomach walls and gather in its throat. At any time after this occurs

when this mosquito bites a well person, she is likely to force some of the parasites into the person's body along with the saliva which she injects into the wound. In this way, after a few days or weeks, a new case of malaria develops. This is one of the most important recent discoveries in medicine.

**How to avoid malaria.** — Since we know how the disease is spread, it becomes possible to prevent it entirely. The malarial regions are simply those where the malaria mosquitoes are abundant. It has been positively proved that it is possible for persons to live even in the worst of such regions and yet to keep entirely well by guarding against being bitten by the mosquitoes. Their bites can be escaped, for usually the malaria mosquitoes are active only between sunset and sunrise. These mosquitoes do not fly far from the places where they breed. The thorough screening of the houses is the most certain means of preventing the spread of the disease. In addition the standing-water pools in which the mosquitoes breed should

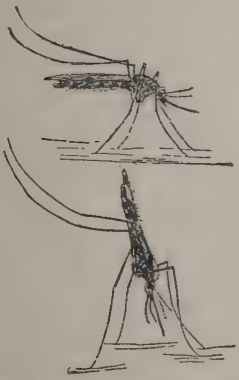


FIG. 165. — MALARIA MOSQUITO (below) AND COMMON MOSQUITO (above)

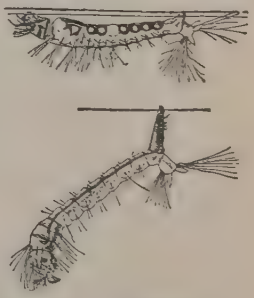


FIG. 166. — WRIGGLER OF MALARIA MOSQUITO (above)

be drained or filled. Small fish live on mosquito wrigglers and hence fish should be kept in ponds that can not be drained or filled.

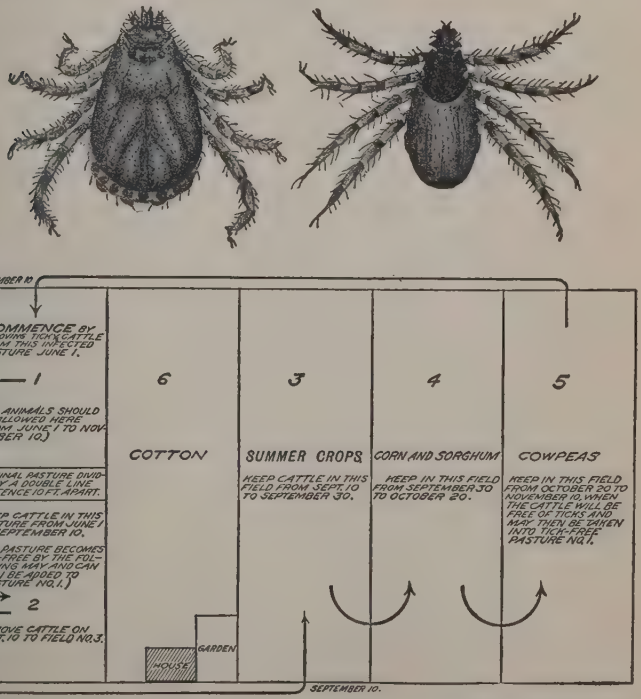
Care should be taken to empty the water at least once a week from drinking troughs, barrels, and the like where mosquitoes may breed. Tin cans or similar water holders should be buried or placed so that they can not hold water. Cisterns and wells should be covered and everything possible done to prevent the multiplication of mosquitoes of any kind. The reward for such work will be a largely increased measure of comfort and health.

**How to know the malaria mosquitoes.** — Whether we desire to destroy or to avoid these mosquitoes, we should know how to tell them from harmless kinds and also be able to tell the larvæ or wrigglers in their breeding places. All of the mosquitoes that are concerned in spreading this disease belong to a single group and are closely related. The adults are rather long-legged as compared with other kinds; when at rest, they stand with their bodies pointing head first to the surface to which they are clinging (Figs. 164 and 165). Other mosquitoes rest with the body parallel to the surface upon which they stand.

Among the larvæ, or wrigglers, these positions are quite reversed, as the malaria kinds are usually found with their bodies just under the surface of the water and parallel to it, while the other kinds hang, head downward, nearly at right angles to the surface (Fig. 166). Green scum is usually present where malaria mosquitoes abound.

**Clearing the South of ticks.** — In somewhat the same way that the mosquito carries malaria among mankind, the cattle tick spreads among cattle the fearful disease, *tick fever*. Fortunately cattle ticks have been completely de-

stroyed during recent years in a large part of the Cotton Belt; now most of the South being free from the fatal disease caused by it, we may expect the last cattle tick in the United States to be destroyed soon. Meanwhile the government maintains a quarantine line to prevent the spread of ticks and tick fever.


NOVEMBER 10
COMMENCE BY REMOVING TICK CATTLE FROM THIS INFECTED PASTURE JUNE 1.
1
(NO ANIMALS SHOULD BE ALLOWED HERE FROM JUNE 1 TO NOVEMBER 10.)
ORIGINAL PASTURE DIVIDED BY A DOUBLE LINE OF FENCE 10 FT. APART.
KEEP CATTLE IN THIS PASTURE FROM JUNE 1 TO SEPTEMBER 10.
(THIS PASTURE BECOMES TICK-FREE BY THE FOLLOWING MAY AND CAN THEN BE ADDED TO PASTURE NO. 1.)
2
REMOVE CATTLE ON SEPT. 10 TO FIELD NO. 3.
6
COTTON
3
SUMMER CROPS
KEEP CATTLE IN THIS FIELD FROM SEPT. 10 TO SEPTEMBER 30.
4
CORN AND SORGHUM
KEEP IN THIS FIELD FROM SEPTEMBER 30 TO OCTOBER 20.
5
COWPEAS
KEEP IN THIS FIELD FROM OCTOBER 20 TO NOVEMBER 10, WHEN THE CATTLE WILL BE FREE OF TICKS AND MAY THEN BE TAKEN INTO TICK-FREE PASTURE NO. 1.
GARDEN
HOUSE
SEPTEMBER 10.

*Courtesy of U. S. Bureau of Animal Industry*

FIG. 167. — THE CATTLE TICK, ENLARGED. MALE ON LEFT; YOUNG FEMALE ON RIGHT; ALSO ONE PLAN OF CLEANING CATTLE AND LAND BY ROTATION OF PASTURES

The cause of tick fever is a tiny parasite, or harmful living thing, that can be seen only by the use of a good microscope. It destroys the red blood cells of the diseased animals.

In the blood that the tick sucks from Southern or other cattle that have once had the disease are the parasites. The mother tick conveys these to her eggs, and these pass them on to the young ticks. When these latter insert their mouth parts into a cow that has not had tick fever, the parasites pass from the tick into the animal and cause it to sicken and often to die. Hence cattle brought south from north of the quarantine line often die with this disease, which is carried to them by ticks.

**How ticks increase.** — A large tick drops from a cow to the ground when too full of blood to suck more, and there lays as many as 3000 eggs. In warm weather these eggs soon hatch into tiny ticks, each about the size of a chicken mite. They crawl up on tall grass or bushes, waiting for a cow to rub them off. Neither old nor young ticks can live on anything but blood. Hence, if no animal comes along, the young ticks starve, but they do not starve quickly. Without food they may live as long as three months in summer and much longer in cool weather. The tick is not classed as an insect, for it has eight legs (Fig. 167).

**How ticks are destroyed.** — Scientists have learned how to make a poison that kills all ticks without harming cattle. It is made of arsenic, tar, and other substances mixed with water; the mixture must be kept at exactly the correct strength. Cattle are regularly dipped in this, that is, made to swim through a vat of the poison liquid every two weeks.

### Practice Work and Questions

1. After doing everything possible to destroy the breeding places of flies near the home, each pupil can destroy many of the flies that get into the house by using the following poisonous bait: To a tablespoonful of formalin or formaldehyde, obtainable at a drug store, add a cup of water, a little sirup, and several tablespoonfuls of milk.

2. Examine any stagnant water near the home or school, as old empty cans, watering troughs, and ponds, for mosquito wrigglers (wiggle-tails). Would you not like to help rid the place of mosquitoes by removing old cans, emptying watering troughs at least once a week, and inducing your parents to drain the ponds or put minnows in them to eat the wrigglers?

## CHAPTER XLIII

## BITING AND SUCKING INSECTS — SOME PESTS OF GARDEN AND ORCHARD

Students of insects have learned how to fight the harmful kinds by observing their manner of eating.

**How insects feed.** — Insects' mouth parts are fitted for either *biting* or for *sucking* food.

Insects have a number of parts to their jaws, and these are so arranged that they work sidewise against each other. The biting insects consume the entire substance of the leaves, flowers, fruit, or wood on which they feed. This is the reason that it is possible to kill such insects by applying some poison to the plants on which they are feeding. All caterpillars have biting mouth parts.

Some biting insects, however, feed in protected places where it is impossible to reach their food with a poison application. This is the case with most wood-boring insects and with the larvæ of the cotton-boll weevil. Many of the leaf-feeding insects feed in the buds or some other protected place that makes it hard to control them. It is, therefore, necessary to know both the structure of the mouth and something of the general feeding habits of each insect before it can be destroyed.

**Different uses of biting mouth parts.** — Among the biting insects the jaws are arranged in two principal positions, either pointing downward toward the surface upon which

the insect rests; or forward, straight ahead of the insect. These positions indicate a different use. When the jaws point downward it means, as a rule, that the insect feeds on the surface or substance upon which it rests. This is the case with the grasshoppers, caterpillars, and most other leaf-feeding insects. Where the jaws point forward,

*Courtesy of Alabama Agricultural Experiment Station*

FIG. 168. — DUSTING FOLIAGE OF SNAP BEANS TO POISON THE MEXICAN BEAN BEETLES

it indicates that they are used for catching prey or for boring into wood. Those insects which catch others are, as a rule, useful and should not be destroyed. The *tiger beetles* and the *ladybirds* are two important groups of such useful insects.

**Sucking insects.** — In the second large group are included all insects that take their food by sucking. The

mosquitoes, flies, butterflies, moths, and bugs are of this class. The food of sucking insects is generally either plant sap or animal blood. The butterflies and moths, however, use neither of these foods but live on the *nectar*, or sweet liquid, which is formed in flowers. Some adult insects never feed at all. The larvæ from which they are developed have stored up so much strength and a surplus of food materials in their body tissues that the adult merely lives upon that reserve. Such insects are usually short-lived while in the adult stage.

FIG. 169. — MEXICAN BEAN BEETLE ON INJURED COWPEA LEAF

With most sucking insects the mouth parts are strong enough to enable them to pierce the tissues of plants, animals, or other insects so that their food is obtained entirely from beneath the surface. This is the reason that *it is impossible to kill sucking insects by applying poisons to the plants on which they are feeding.*

**Different treatments for biting and for sucking insects.** — These types of mouth parts must be well understood in deciding just what treatment should be given for any insect pest. With the biting leaf-eating insects any poison spread on the surface of the leaves will be taken into the insect's

*Courtesy of Alabama Agricultural Experiment Station*

FIG. 170. — FOLIAGE OF SNAP BEANS DESTROYED BY MEXICAN BEAN BEETLE

*Courtesy of New Jersey Agricultural Experiment Station*

FIG. 171. — KILLING PEACH TREE BORERS BY GAS FROM P-C-BENZENE (in white ring)

stomach with its food and cause its death. Arsenate of lead and calcium arsenate are the principal poisons used in this way. They are either dusted on the plants or mixed with water and the poisoned solution sprayed all over the trees or plants on which leaf-eating insects are feeding. Such a treatment will have no effect on the sap-sucking insects that take nothing from

the surface of the leaves. It has never been possible to introduce any poison into the sap of a plant so as to destroy the insects sucking or eating it. The principal thing that can be done to destroy such insects is to apply something which will not injure the plant but which, coming into contact with the insect's body, will cause its death. There are two kinds of such treatments that can be used. The first includes many substances which cause death by covering with soap or with oil the openings through which the insect breathes, thus keeping out the air and really suffocating it. These are called *contact insecticides*. Kerosene emulsion is one of the most common of such substances. (See Appendix.) The second class includes those gases that are either poisonous in themselves or cause the death of the insect by replacing the air and thus causing suffocation. One of these is carbon disulfid.

*Courtesy of U. S. Bureau of Entomology*

FIG. 172. — LARVA OF CODLING MOTH IN APPLE

**The potato beetle.** — So commonly does this insect occur that it is probably well known to everyone. The adult is marked with ten light and dark stripes. The beetle lives through the winter and lays its eggs upon the potato plants early in the season. The eggs hatch into small reddish

grubs and in a few weeks the vines may be eaten bare. One remedy for this pest is arsenate of lead sprayed or dusted on the leaves.

**The Mexican bean beetle.** — Although new to the South, this insect is already threatening to rival the cotton-boll weevil in destructiveness and to exceed the latter in rapidity and extent of spread. The Mexican bean beetle was apparently introduced into the region around Birmingham, Alabama, in shipments of hay from the arid West about 1918 or 1919. From that center it rapidly spread, especially towards the north and northeast.

Fig. 173. — Young Apples in Condition to Be Sprayed against Codling Moth

Note the wide spread of the sepals.

The mature beetles and the larvæ completely consume the green part of the leaves of snap and butter beans. Later they attack cowpeas (Fig. 169) and, to a lesser extent, soy beans and certain other legumes. The mature insect is brownish-yellow with sixteen small black spots on its rounded back. The yellow larvæ are covered with stout barbs, or spines.

The insect in the adult form passes the winter hidden under trash. In the spring it lays a large number of eggs on the leaves of beans. These require only about a month to develop into egg-laying beetles, and therefore by summer, or before, these destructive insects have increased to countless numbers.

Among the methods of reducing the injury from the Mexican bean beetle are the following: (1) destroying in winter all remnants of food plants and adjacent litter; (2)

early planting of early varieties of the plants attacked; and (3) spraying or dusting with poisons.[1] Although this is a biting insect, its control by poisons is not easy. Arsenite of zinc has been recommended; 1 ounce of this to 3 gallons of water usually kills many of the insects without injury to the tender foliage of beans. Spray should be so applied as to reach the under side of the leaves.

*Courtesy of U. S. Department of Agriculture*

FIG. 174. — CROP OF BEN DAVIS APPLES FROM A SPRAYED TREE

One method of reducing damage in the fields is by substituting for cowpeas one of the legumes that escapes attack, especially the velvet bean.

**The peach borer.** — One of the most destructive peach pests is the peach borer, which works not upon the fruit

[1] A poisonous mixture for dusting plants, successfully used by the Alabama Agricultural Experiment Station in 1922, consisted of one part each of tricalcium arsenate and sulfur and four parts of slaked lime.

but in the trees. If constant care is not taken, these borers may destroy a valuable orchard in a few years. The adult is a beautiful little moth, resembling some of the wasps in appearance. The eggs are laid by the parent moths during the summer upon the bark near the surface of the ground. After hatching, the larva begins to bore into the bark, working downward a little below the surface. It lives thereafter in the sap-carrying layers just under the bark. Its presence is marked by an abundant formation of gum. The usual remedy is to dig around the base of each tree early in the fall or winter, and, if any signs of gum are found, to dig out and destroy the larvæ or worms. This must be done carefully. To make easier the digging out of the worms, the moth may be made to lay its eggs higher up on the trunk. This is done by heaping up the soil in July around the base of the tree until the slender mound is about eight inches above the surface. Before October the eggs will have been

*Courtesy of U. S. Department of Agriculture*

FIG. 175. — CRATES OF PEACHES SHOWING THAT SPRAYING CHECKS DEVELOPMENT OF BROWN ROT DURING SHIPMENT

laid in the bark at about the top of the mound. The mound is leveled about the middle of October and the borers are scraped off with a pocket knife or iron scraper. The trunks should then be painted with a caustic wash.

Fig. 176. — San José Scales, Enlarged

There is a newer treatment for peach trees that are four years old or older. This consists in killing the borers in the tree with the poison gas that slowly escapes from a powder, which, for short, we may call "p-c-benzene." First the gum on the tree is scraped off and the soil around the tree made smooth and level. Next the poison is so placed as to make a ring of white powder about two inches from the trunk (Fig. 171). This powder is then carefully covered several inches deep with fine soil to confine the gas that escapes. After a few weeks the soil containing the chemical is removed and replaced by untreated soil. The proper time for this treatment is early in the fall.

**The apple worm or codling moth.** — A widespread pest of apples is the worm (Fig. 171) that works into the core and makes the fruit "wormy." This is the larvæ of a pretty moth that lays its eggs on the leaves of the apple *soon after the blossoming time.* The young larvæ feed on the leaves before they enter the fruit, into which they bore their way. This is the reason why it is possible to kill nearly all of the young worms by applying a poisonous spray, which usually contains arsenate of lead, at about the time that the petals drop from the blossoms

(Fig. 173). A second spraying should be made ten days to three weeks after the first.

**The curculio that causes wormy peaches.** — There is another beetle that does great damage to the plum and peach crops. The adult is a dark gray snout beetle, or weevil. After the fruit has set, the mother weevil lays her eggs in it and then eats a crescent-shaped cut half around each egg in order that the growth of the fruit may not crush the egg before it hatches. This always marks the location of the egg. The larva eats its way into the fruit and around the stone. When fully grown, it leaves the fruit and goes into the ground to transform. The adult weevil comes out early in the spring and feeds for a time on the buds before the fruit is set. The curculio may be destroyed by spraying the fruit and leaves three or four times with arsenate of lead; begin just after blossoming and repeat the spraying at intervals of about ten days or two weeks.

**The San José scale.** — This is one of the most destructive enemies of all fruit trees that shed their leaves. It is called the San José scale because it was first found in the United States near a place in California by that name. The scale insects are true bugs and *suck the sap* from the trees. The adult female scales are hardly as large as pinheads, but they may occur so abundantly as to cover the bark completely, and to cause the death of large trees in a few years (Fig. 176). A good treatment is to spray the trees thoroughly, just before the leaves start in the spring, with a solution made by boiling lime and sulfur together. This is known as the *lime-sulfur wash*. (See Appendix for directions.)

**The Argentine ant.** — This serious and newly introduced pest from South America is rapidly spreading from Southern

seaports. Although this is one of the smallest of the ants, it is the most troublesome in the home and poultry yard and as an indirect enemy of certain fruits, vegetables, and field crops. Its chief damage to most crops and trees is by caring for and spreading other injurious insects, such as scale insects on trees and mealy bugs on sugar cane. The Argentine ant is an enemy of cotton in that it drives away other species of ants that destroy some of the immature boll weevils.

The nests of the Argentine ant are usually found about the roots of trees and the foundations of houses. In these nests are the egg-laying queens, which are fed by the worker ants with food that the workers have first swallowed. Hence the poison must be one that acts slowly so as not to kill the worker ants before they have carried the poisoned food to their queens. Directions for preparing and using this poison bait will be sent on application to any State agricultural college.

### Practice Work and Questions

1. Examine the mouth parts of some large beetle or grasshopper, and write in your notebook a statement about the kind of mouth parts found.

2. Dig out the borers in the bark at the base of some old peach tree. Record in your notebook the number found, and bring specimens to school.

3. Find all the insects you can that attack cabbages, collards, or turnips, looking especially for the following: (*a*) tiny plant lice; (*b*) very small caterpillars cutting off the leaves of young turnip plants or eating older leaves; (*c*) greenish caterpillars eating holes in the leaves; and (*d*), in hot weather, the "calico-back" bug, brightly marked with white, black, and yellow.

## CHAPTER XLIV

## SOME INSECT ENEMIES OF CORN AND COTTON

The production of cotton has been rendered much more expensive and uncertain since the Mexican cotton-boll weevil has spread over most of the Cotton Belt. Its damage each year amounts to hundreds of millions of dollars. Cotton has other insect enemies. Many insects also attack the corn plant or its grain.

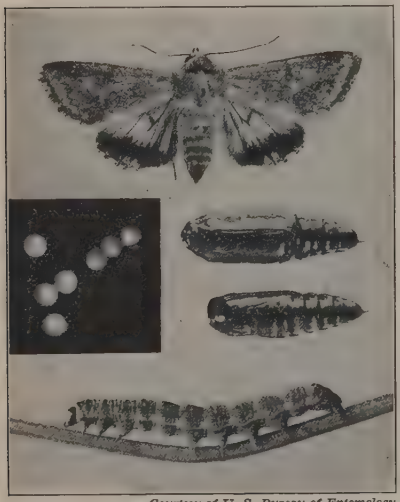
**The grass worm.** — During any summer farmers over a wide extent of country may find suddenly that countless numbers of slender striped caterpillars are destroying the grasses and then eating the leaves of young corn, sorghum, and alfalfa. These grass worms also attack most of the other cultivated forage crops.

The caterpillars are hatched from eggs laid on the leaves by a gray moth. These worms feed on foliage until they are fully grown. Then they enter the soil near the plants where they have fed. Here they transform and come out in about ten days as moths, which lay eggs for another generation of caterpillars. Hence, one of the methods of fighting this pest consists in cultivating the field during this period of change, when most of the caterpillars have left the plants for the soil.

While the larvæ are feeding, the plants are sprayed with arsenate of lead, one pound of this powdered poison being dissolved in fifty gallons of water; or the plants are dusted

with the same poison or with calcium arsenate. Later in the season there is usually such an increase in the various insect enemies of the caterpillars that these parasites check or destroy the grass worms.

**Weevils in stored corn.** — The principal insect that damages stored corn in the South is the so-called black, or "rice," weevil. This and other species of beetles and small moths annually destroy in the warmer parts of the South corn worth many millions of dollars. Most of this loss may be prevented by any of the following means:



*Courtesy of U. S. Bureau of Entomology*

FIG. 177. — FOUR STAGES OF THE COTTON BOLLWORM, ENLARGED

(1) Planting only varieties, or selected ears, having a tight covering of shuck at the tip of the ear;

(2) Planting in the cornfield a few rows of extra early corn. This early trap corn should mature three weeks ahead of the other corn so that its ripening grains may attract weevils. Such early ears with shucks should be removed within six weeks after passing the "roasting-ear stage." These ears and the weevils in them should be promptly fed to live stock;

(3) Shucking the ears of the main crop before placing them in the crib so as to leave no winter shelter for the weevils;

(4) Planting corn very late.

**The cotton bollworm.** — This caterpillar (Fig. 177) bores into cotton bolls, green tomatoes, and into ears of corn. The gray moth lays her eggs on these and other plants. These worms prefer corn ears to cotton bolls. That is, if corn that has not become hard or mature is near, the bollworm moths will place nearly all of their eggs on the corn. By planting a few rows of corn at intervals of two weeks it is possible to have the corn silking and in condition to attract the moths when they are most abundant in July and August. The cotton is left almost uninjured. This practice is in addition to that of plowing the ground early in the winter to break up the cells in which the pupæ are passing the winter.

**The cotton-leaf worm.** — The caterpillars seldom become abundant until rather late in the season and may then strip all the foliage from the plants. They may quite easily be reduced in numbers by dusting the cotton plants with calcium arsenate. This worm, when it comes late in the growing season, is beneficial to the next crop, for it deprives the boll weevil of food by practically killing the cotton plant.

### Practice Work and Questions

1. Examine ears of corn that have been stored to see whether the grains have been attacked by black weevils or by other insects. Estimate the proportion of the grains that have been attacked.

2. If injured grains are found, plant twenty of them in a box or can indoors and an equal number of sound grains. In about ten days note which have germinated best and record in your notebook.

## CHAPTER XLV

## THE MEXICAN COTTON-BOLL WEEVIL

This insect came into Texas from Mexico about 1892 and has steadily spread eastward over the Cotton Belt. The Mexican cotton-boll weevil (Fig. 178) attacks only cotton.

**The egg.** — The adult weevils that have lived through the winter are ready to attack cotton as soon as the first squares are formed in the spring. The eggs are very small and are laid in a hole which the female eats in the square or boll. After placing the egg at the bottom of the hole, the opening to it is sealed air-tight by the mother weevil so that the egg will not dry up and fail to hatch. Each female may lay more than a hundred eggs. Only a few days are required for these to hatch.

**The larva.** — On hatching, the little larva, or grub, finds itself surrounded by the tender parts of the bud or boll and proceeds to feed and grow. When the larva has become about half-grown, the injury to the square is usually so severe that the little leaflike parts surrounding the bud spread outward and the square turns yellow. In about ten days from the time the egg is laid the square usually falls to the ground, where the larva continues to feed within it until fully grown (Figs. 179, 180). This requires only about ten to fifteen days. Dry, hot weather may kill the insects within the fallen squares, especially if the soil is sandy.

**The pupa.** — Within the shelter of the walls of the fallen bud or square or within the boll (which is more likely to remain hanging upon the plant), the larva changes to a pupa. After only about three days more it becomes a full-grown weevil. The weevil then cuts a hole in the surrounding walls, just the size of its body, and through this opening it makes its escape to the outside world. All its life from the time the egg is laid until the mature weevil comes forth is passed in the interior of the square or boll. This fact makes it impossible to apply any poisons to destroy the insect in its early stages.

*Courtesy of U. S. Bureau of Entomology*

FIG. 178. — THE COTTON-BOLL WEEVIL, ENLARGED

Above, adult with wings spread; left center, egg much enlarged; right center, larva; below on left, pupa; on right, adult with wings closed.

**The adult.** — The mature weevil (Fig. 178) is a gray or reddish-brown insect about a quarter of an inch long, including the long snout. The mouth parts are very small and are at the extreme tip of the long snout. This enables the weevil to bore deep into the squares and bolls. Squares, blooms, and bolls are destroyed by the attacks of the mature weevils, by the injury caused by the growing grub, and

by the decay which starts in such wounds. The adults, or weevils, may live for a number of months. The development is so rapid that fully five generations may reach maturity in a season. Hence, the insects are most abundant in the late summer and in the fall. The only check to the increase of weevils is the absence of squares, blooms, and bolls. When the weevils are very numerous, they destroy the squares so completely that no blooms are formed.

*Courtesy of U. S. Bureau of Entomology*

FIG. 179. — BOLL-WEEVIL LARVA IN A SQUARE OF COTTON

**How it passes the winter.** — The weevils which reach maturity late in the fall are most likely to live through the winter. Fortunately only from one to ten weevils live through the winter out of every hundred that attempt to do so. The weevils that mature in the late fall find shelter in the old cotton bolls on the stalk or under any rubbish in or around the fields. The few that survive the winter leave their places of shelter gradually during a period of ten to fourteen weeks, as a rule between the last of March and the first of July. This gradual coming out from winter quarters makes it very difficult to do much to control the weevil early in the spring.

**Insect and bird enemies.** — The boll weevil has proved

very difficult to control. It has been found that the direct rays of the sun will destroy large numbers of the insects while in the immature stages in the fallen squares, when they are exposed to it. Some of our native ants which occur all through the cotton-growing area are very valuable helps, because they destroy large numbers of the pest in its immature stages. A number of other insects attack the immature weevils in the squares and bolls and destroy them. More than forty species of birds are known to destroy boll weevils. The most important are the swallows and orioles in summer and blackbirds and meadow larks in winter.

*Courtesy of U. S. Bureau of Entomology*

FIG. 180 — BOLL-WEEVIL LARVÆ IN A BOLL

Another step in fighting the boll weevil consists in destroying the green parts of the plants or in plowing under the cotton stalks as early as possible in the fall. This is done in order to deprive the weevils of their only food supply, to stop their increase, and to reduce the number of hiding places in which they may spend the winter. Other hiding places near the cotton fields should also be destroyed.

**Picking weevils and squares.** — The first fight against the weevils after they come out of their winter hiding places consists in picking the few mature weevils found on the buds of the young plants just as squares begin to form. One may reduce the numbers in later generations of weevils by

picking up and destroying punctured squares, beginning fifteen days after the first bloom appears in the field. These punctured squares are picked and destroyed every fifth day during at least the first few weeks after the punctured squares begin to fall.

FIG. 181. — POISONING COTTON-BOLL WEEVILS

**Poisoning boll weevils.** — Destruction by poisoning is difficult and somewhat expensive. The best poison to use is calcium arsenate. This very fine powder is dusted on the leaves about four times (Fig. 181). Poisoning is done about every fifth day and begins when about one eighth of the squares have been punctured. The poison settles and sticks best when put on at night or in the early morning.

**The newest method of control.** — In 1922 the Florida Experiment Station very successfully controlled boll weevils by stripping off all squares, punctured or not, and immediately blowing calcium arsenate once only into the leaf buds of the little plants. This was done as soon as most of the boll weevils had come out from their winter quarters. Deprived of all squares, the weevils fed more freely on the poisoned leaf buds. This method requires less poison and less labor.

**Hastening maturity.** — The most important step is to push the cotton plant to rapid maturity so that the bolls formed early in the summer may become well grown by the time the weevils become very numerous—about the middle of July or first of August. The boll weevil does not do much damage to maturing bolls while unpunctured squares are abundant.

The maturity of cotton may be hastened: (1) by planting varieties or selections that ripen rapidly or that form bolls early in the summer, (2) by early planting and frequent and thorough cultivation, and (3) by the liberal use of fertilizers. Usually acid phosphate hastens the maturing of cotton.

PRACTICE WORK AND QUESTIONS

1. If this lesson is studied when boll weevils are active, observe the mature weevils; open the squares and bolls that have been attacked to see the larvæ at work; and feel on the outside of squares and bolls for the little rough projections that show where punctures have been made.

2. **Home project.** Prove to the neighbors that the boll weevil may be held in check where you live by the newest method of control. Strip off and destroy the first few squares from the tiny plants on an acre, and then blow poison from a dust gun into the bud of every plant the same day you strip the squares. Be careful to leave no square behind. Choose the right time, and apply the poison within a few hours after collecting the squares. Write down each step and especially the weight of seed cotton from an acre thus treated and from a similar acre not treated.

## CHAPTER XLVI

## BEEKEEPING

Many a boy and girl now owns and cares for a few colonies of bees. Usually these young persons have the help of the county home demonstration agent. Equipped with bee veil and smoker, owners of bees who understand the habits of these interesting insects are seldom stung. Experienced beekeepers are able to take up masses of bees in their bare hands without getting stung. This is largely because they are careful not to mash any bees and because they avoid making quick motions or jarring the hives.

The keeping of bees for the production of honey is an important industry in many sections of the country and is practiced to some extent nearly everywhere. The occurrence of nectar in flowers and the visits of the bees and other insects to the flowers to secure it are well known.

**The members of a colony.** — The *workers* number from a few thousand to about 100,000 in a hive. These do all the work of collecting and storing the honey and all the housekeeping in the hive. Besides the workers there are a few male bees, or *drones*, and usually only one *queen* (Figs. 182-184). If more than one queen is present, there will be warfare between the two until one is killed; or if the colony is strong and the honey supply abundant, part of the workers may leave the old hive with the old queen and found another colony. This is called *swarming*.

**Swarming.** — One important task of the beekeeper is to watch for swarms and to settle them in empty hives (Fig. 185). He knows that the time of swarming is near at hand when he finds queen larvæ in the queen cells (Fig. 186); these are the cells that are larger than the others and that somewhat resemble unhulled peanuts. Sometimes he wishes

Fig. 182.
Worker Bee

Fig. 183.
Drone Bee

Fig. 184.
Queen Bee

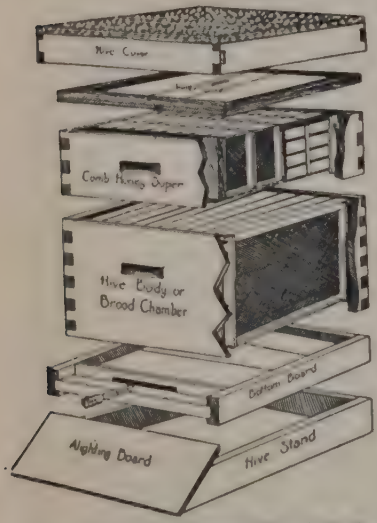
to prevent swarming so as to increase the production of honey. One means of preventing swarming consists in clipping the wings of the fertile queen, so that she can not fly; then the queen cells are removed.

**The work of the queen.** — The queen bee is very carefully cared for by the workers, for on her depends the very life of the colony. They feed her and do everything else possible for her comfort and safety. The reason for all this anxiety about the queen is that she alone lays all of the many thousands of eggs for the colony. Her strength is saved for that work.

**The bee nursery.** — The worker bees build the *honeycomb* in which the honey is stored and in which the young bees are reared. While the honey is stored for food, the young bees are not fed on it directly. They are not brought up in the cells with the honey. This is how it is possible to have the fine solid combs of pure honey.

When a comb is prepared for the rearing of the young,

the queen places one egg in the bottom, or rather in the inner end, of each cell. With that her work is done. But during the summer time, she may have to lay several hundreds or even thousands of eggs every day. Whether the young bee is to become a worker, a drone, or a queen depends largely on the kind of cell in which the egg is placed and also on the kind of food that the young bee is fed. The workers are developed in the ordinary-sized horizontal cells. The drone cells are slightly larger but also horizontal. The workers can produce a queen when they desire by forming a larger vertical cell, placing in it an ordinary worker egg, and then feeding the young larva on a special kind of food which is called *royal jelly*.




Courtesy of The A. I. Root Co.

FIG. 185. — A MODERN BEEHIVE, TAKEN APART

The bee larvæ are little legless creatures and are fed and cared for entirely by the workers. Their food is a mixture of honey and pollen. After they become adult, they do not leave the hive for some days but serve as nurses for the larvæ still in the cells. In about two weeks they also begin the collection of honey.

**How honey is made.** — When collecting honey, a bee

usually visits only one kind of flowers on a trip. The sweet nectar is carried in a special stomach from which the bee is able to expel it again for storage in the honeycomb. Upon its legs and body the bee carries pollen from the flowers it has visited. Bees really gather nectar, not honey. After the nectar has been stored in the comb, the bees fan it with their wings and dry out much of the water, and in due time it ripens into real honey.

So many things must be known in order to manage bees successfully that it has become a special business to which many people give all their time. On the amount of honey produced each year depends the value of a colony of bees. From well-managed hives of selected bees and during seasons favorable for the growth of the honey-producing plants as much as a hundred pounds or more of honey may be stored by a single colony.

*Courtesy of Connecticut State Experiment Station*

FIG. 186. — QUEEN CELLS
Shown in lower part of the illustration.

**Length of life of bees.** — The life of a colony of bees may be continued indefinitely, but the life of the individual workers is only about six weeks in the summer when they are flying a great deal. They wear

their wings out and thus really work themselves to death in a few weeks. The drones are usually killed by the workers during the fall, or when there is a scant supply of honey, but the queen may live for several years. When a queen becomes old or exhausted, a new one takes her place and the life of the colony goes on steadily.

*Courtesy of Texas Agricultural Experiment Station*

FIG. 187. — EXAMINING A HIVE OF BEES

**Producing select hives of bees.** — The most popular kind or race of bees is the Italian. Most beekeepers prefer these because they are gentle, increase rapidly, and store large amounts of honey. By placing a single fertile Italian queen in a hive of common bees from which its own queen has been removed, all of the bees after a few weeks will be of the same kind as the new queen because she lays all the eggs. This is the way colonies of choice bees are produced.

**Selling queens and workers.** — Some skilled beekeepers make more profit from the sale of queens than from honey. Small ventilated cages containing a queen or a few pounds

of bees may be shipped long distances by mail to beekeepers in colder climates where bees do not begin to increase so early in the spring as do bees in the South.

**Honey-producing plants.** — For the best results with bees it is important that there be an abundance of honey-producing plants in the vicinity of the hives. Among the best plants for this are white and crimson clover, alfalfa, and many of the common fruit trees. Sweet clover, which grows wild and also is cultivated on lime soils in the Southern States, is an excellent bee plant. The annual white sweet clover, also called *hubam*, is especially valued by owners of bees. Many of the wild flowers and weeds are sources of abundant honey supply. Among the most important of the wild plants of the South that afford much honey are the tupelo gum and sourwood trees; the gallberry shrub that grows so extensively in the long-leaf pine forests; and among the weeds, goldenrod and asters.

Before one undertakes beekeeping on an extensive scale, he should become well acquainted with the kinds and abundance of honey-producing plants growing near by. Whoever would succeed in managing bees must be willing to examine the hives frequently (Fig. 187) and to spend much time in keeping the bees comfortable and free from attacks of insects and disease.

### Practice Work and Questions

1. At some spot where bees go for water or for food, catch a worker bee, using a wide-mouth bottle. Write in your notebook at least three facts that you observe as you watch this interesting insect.
2. What bee plants mentioned in this chapter grow in abundance within a mile or two of your home? Write this list.
3. Watch bees at work to learn what trees, crop plants, and weeds they visit. What are the important bee plants growing near your home?

## CHAPTER XLVII

## IMPROVEMENT OF LIVE STOCK— BREEDS OF HORSES AND SHEEP

The principal animals that add to farmers' profits are horses, mules, cattle, sheep, and swine. All have been greatly changed by man in order that they may better serve his uses. The active, slender, long-legged wild hog has been changed into the round-bodied, short-legged Berkshire or Poland-China. The angular, long-horned wild cattle of earlier days have been transformed into immense masses of flesh (Fig. 188).

The changes that have occurred in domestic animals have been brought about chiefly by selection of the ones best suited to their owner's main purpose. Improvement in the kind and amount of food has also helped to make these changes (Fig. 189).

**Improving common or scrub live stock.** — A breed is a large group of animals that resemble each other and whose offspring inherit the same qualities. A pure-bred animal is one both of whose parents belong to the same breed. Scrubs, or natives, have no ancestors that belonged to any distinct breed. Grades are descended from both pure-bred and scrub ancestors.

Fortunately for the farmer the pure-bred parent has more influence than the scrub in determining the form, color, and useful qualities of the grade offspring. Hence,

the best way to improve cattle or other live stock cheaply is to purchase pure-bred sires, or males, and to use cheaper females. Starting with a pure-bred sire and scrub females the first generation consists of half-bloods. The second generation (the offspring of these half-blood females and of

Fig. 188. — Yearling Angus Steer and a Scrub Three Years Old

a pure-bred sire) are three-quarters pure; the members of the fourth generation are seven-eighths pure, or high grades. The process of improving inferior animals by the use of pure-bred sires is called *grading up*. It is the cheapest way for most farmers to improve their herds. The cheaper females intended as a foundation for the herd or flock ought to be selected from the best of their kind.

The high grades may be just as good for butter or beef or other special use as are the pure-bred animals, but for purposes of increase they are less valuable. This is because some of their offspring may resemble their *scrub* ancestors.

FIG. 189. — A GOOD BREED OF LIVE STOCK WELL TENDED MAKES PASTURE LAND PROFITABLE

It is unwise, therefore, to use either a grade or a scrub sire. A cross-bred animal has one parent belonging to one breed and the other parent to another. When the parents are widely unlike, the character of the offspring is uncertain. Such violent crosses are usually unwise.

**Advantages of raising live stock.** — There are advantages in raising some live stock even on farms devoted

chiefly to cotton, sugar cane, tobacco, or grain. Some of the main reasons why live stock ought to be raised on most farms are: (1) because they make profitable use of much grass and other coarse food that would otherwise be wasted; (2) because they enrich the farm directly by con-

*Courtesy of U. S. Department of Agriculture*

FIG. 190. — IMPORTED PERCHERON STALLIONS

verting most of their food into fertilizing material; (3) because they enrich the farm indirectly by causing the farmer to grow more velvet beans, clover, and other soil-improving forage plants.

**Draft horses.** — These are immense animals, usually weighing from 1500 to 2000 pounds. Their legs are rather short, very strong, and placed wide apart. Their bodies

are rounded; their backs are broad, showing great development of muscles. Their shoulders are rather upright instead of sloping; this upright position enables them to throw their weight and strength squarely against the collar. Their feet

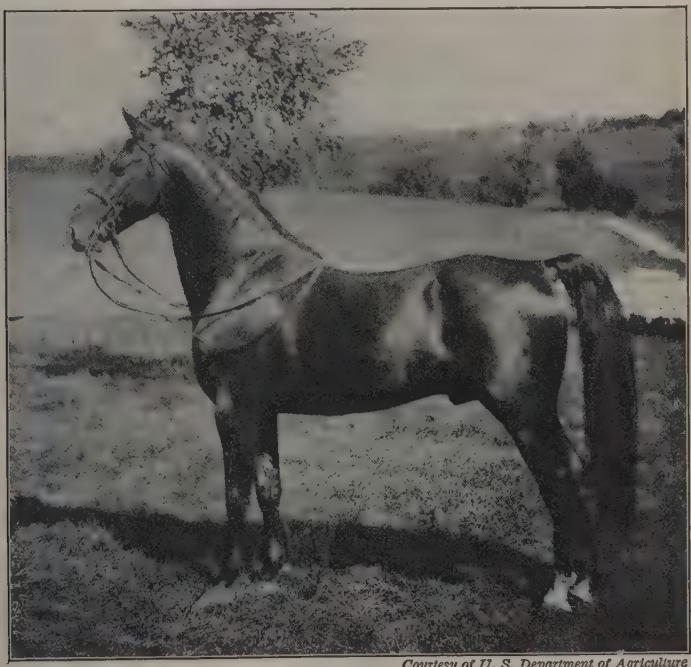
*Photo by Hildebrand*

FIG. 191. — A PRIZE-WINNING PERCHERON MARE

are large. Two of the most popular breeds are the Percheron (Fig. 190) from France and the Clydesdale from Scotland. The latter has a fringe of long hair growing out behind the

lower portion of the leg; often there is white on the face and feet.

**Light driving and riding horses.** — These are formed for speed and hence have slender bodies, sloping shoulders, and



*Courtesy of U. S. Department of Agriculture*

FIG. 192. — MONTGOMERY CHIEF — AN AMERICAN SADDLE HORSE

long legs with sloping pasterns. Thoroughbreds are horses that are very speedy at the running gait.

American trotters owe their speed largely to their

thoroughbred or running ancestors. They are largely used as buggy horses. The colors are various.

The American saddle horse is prized for its easy riding gaits. The best saddle horses are expected to have five gaits; namely, (1) walk, (2) trot, (3) canter, (4) rack (another

*Courtesy of Rufus W. Stimson*

FIG. 193. — A SHETLAND PONY AND OWNER

name for single-foot), and (5) either the running walk or slow pace or fox trot. The saddle horse should be of medium size, graceful proportions, and should have stylish action and a good disposition (Fig. 192).

**Shetland ponies.** — These little animals are useful for children to ride and drive. They are usually gentle and

make delightful pets. The height is oftenest from 36 to 42 inches (Fig. 193). Some ponies have been only 30 inches high. Most Shetland ponies are compact, or "blocky," in form and stronger than their small size would suggest. Common colors are black, bay, and brown; grays, chestnuts, roans, and spotted ponies are not unusual.

**Mules.** — On Southern farms mules are preferred to horses. They pull more steadily, are less high-spirited, and are put to work at an earlier age. Southern farmers can easily and profitably raise their own mules.

*From Sampson's Effective Farming*

FIG. 194. — DORSET EWES

**Sheep.** — Before cotton was known, men and women wore garments made of wool. The sheep still furnishes a large part of our clothing. This animal is as useful for its flesh, called mutton, as for its wool.

Sheep are more easily kept than almost any other animal. They live chiefly on coarse feed that would otherwise be wasted and eat weeds which horses, cattle, and hogs will not touch. Thus they help to keep the farm clean and neat and improve the land on which they pasture. The wool ordinarily pays the cost of keeping sheep. The lambs are clear profit, and usually a flock produces more lambs than there are ewes. A lamb will often sell when a few months old for as much or more than its mother.

Unfortunately sheep are subject to injury and death from worms in the stomach and intestines. Hence there should be frequent changes of pasture.

There are three types of sheep: fine-wool, medium-wool, and long-wool. The long-wool breeds, which are used both

*Photo by Hildebrand*

FIG. 195. — A SHROPSHIRE RAM

for mutton and wool, have not been extensively raised in warm climates.

**Some popular breeds of sheep.** — The medium-wool breeds include the Dorset, Southdown, Shropshire, Hampshire, and others. They afford good mutton and a fair amount of wool. The Dorset is a sheep of medium size (Fig. 194). Both sexes have horns. Dorsets are prized for

the early date at which their lambs come and for the frequent occurrence of twin lambs.

**The Shropshire** (Fig. 195) is of medium size or above. It is a popular breed in all parts of the United States. The color of the face, ears, and legs is very dark.

**The Southdown** (Fig. 196) is a favorite mutton breed over almost the whole world. Its face, ears, and legs are of a brownish color. The Southdown is smaller than the Shropshire and affords somewhat less wool.

Fig. 196. — A Southdown and His Owner

**The Hampshire** is a large sheep with black face and legs. Shropshires, Southdowns, and Hampshires have no horns. These three breeds are favorites for mutton. The several breeds of Merinos are prized for their heavy fleeces of fine wool (Fig. 197).

### Practice Work and Questions

1. Write in your notebook the names of three coarse feeds growing on the home farm that would be wasted if no live stock were kept.

2. Compare several horses with regard to the following points: slope of shoulders; slope of pasterns (the part of the leg just above the foot); size or fineness of the bones in the lower part of the leg.

Courtesy of University of Illinois

FIG. 197. — A PRIZE-WINNING RAMBOUILLET

Have you read "Black Beauty," a book that tells a very interesting tale about a horse? In reading it you will find not only pleasure but also many useful hints about the proper management of horses.

3. The next time you see a flock of sheep grazing, notice the weeds that they consume which other live stock would not eat. Ask your parents in what month sheep are sheared. Does anyone near you shear his sheep by machinery?

## CHAPTER XLVIII

## BREEDS OF CATTLE AND HOGS

The Hereford, Aberdeen-Angus, Shorthorn, and Red Polled are the most important of the beef breeds of cattle, while the Jersey, Guernsey, and Holstein breeds are raised for their dairy products.

**The beef type.** — The chief use of the beef breeds is to furnish meat. The form desirable in a beef animal is one that affords the largest proportion of valuable meat and the smallest proportion of inferior meat and waste. Hence, the neck and legs should be short and the body full, deep, and rounded. The shape of a beef animal's body is "blocky" and somewhat like that of a brick set on edge with the edges and corners rounded off (Fig. 198). The best cuts are those from the upper part of the body, especially in the region of the loins. The back and loins of a beef animal, therefore, should be broad and deeply covered with flesh. The hind quarters must be fleshy. Cows of the beef breeds usually give only enough milk for their calves.

Most beef breeds that are popular in the United States originated in England and Scotland. A mature cow of the beef breeds often weighs 1500 pounds or more, or nearly twice the weight of a scrub or Jersey cow. The males sometimes weigh more than 2500 pounds.

Even grade animals of the beef breeds are better than scrubs because they grow larger, mature earlier, and afford

a larger proportion of valuable meat. All these advantages can be obtained by the purchase of a pure-bred sire.

**The Hereford breed.** — These cattle are very often called "White Faces" (Fig. 198). The face, breast, legs, under portion, and part of the neck are white; most of the body is red.

*Photo by Hildebrand*

FIG. 198. — A GRAND CHAMPION HEREFORD BULL FROM GEORGIA

**The Aberdeen-Angus breed.** — Other popular names for this breed are Polled Angus and Black Polled. The color is black over the entire body. There are no horns; even among the half-blood Angus grades very few animals have horns. In size the Angus is slightly below the Hereford and

Shorthorn. It has a very blocky, rounded body. The Galloway is another black, hornless breed.

**The Shorthorn breed.** — The horns are short, and in the cow they are gracefully curved. The principal colors are (1) solid red, (2) red and white mixed, and (3) roan, that is, a mottling of red and white. The Shorthorns are widely

FIG. 199. — A GRAND CHAMPION ANGUS COW FROM ALABAMA

distributed over the United States. They are most valuable for beef, but in some families of Shorthorns the milk-producing quality has been maintained.

**The Red Polled breed.** — These hornless red cattle stand between the beef and the dairy breeds. Red Polled cattle are smaller and generally less "blocky" than the beef

breeds mentioned above. Their bodies, however, are rounded and plump. The breed includes many excellent milkers and also many animals of the beef type.

**The dairy type of cattle.** — The form of a good dairy cow should be almost the opposite of that of a good beef cow. She should have a thin back, wide, prominent, bony hips, and lean hind quarters (Fig. 200). If there is much flesh on the back, loins, and hind quarters of a dairy cow,

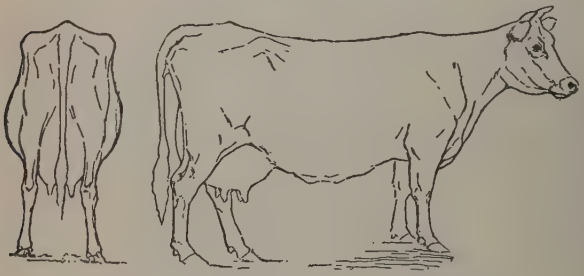


Fig. 200. — Drawings Showing Dairy Form

she has made wrong use of her food, which should have been changed into milk or butter.

The barrel, or rear portion of the body, must be large so that in it she may store away much food while converting it into milk and butter. Viewed from the side, her body should be deeper at the hind flank than at the fore flank, giving a wedge-shaped appearance. Viewed from above, the dairy cow should also be wedge-shaped, having the narrow part at the withers on top of the shoulder blades and the wide part at the hips.

The udder should be large and should extend well for-

ward. The loose skin forming its rear portion should extend as high as possible. The milk veins in front of the udder should be large and crooked, and the "milk well" where they enter the chest cavity should be large. The milk veins carry blood from the udder where it has helped make

Fig. 201. — Jersey Cow, Lad's Iota 350672
Record: 18,632 lbs. milk and 1,048.07 lbs. butter fat in one year, exceeding all other Jersey records to 1922.

milk. If they are large, it shows that much blood flows past the udder for use in making milk.

**The Jersey breed.** — This is now the most widely used dairy breed in the United States. Because her milk is so rich, a Jersey cow often produces more than 500 pounds of butter fat in a year, and some have records of more than twice that amount (Fig. 201).

The Jersey cow has a deep, angular, lean body, a fine and beautiful head with short graceful horns, and usually a rich-yellowish skin. Common colors among Jerseys are silver-gray and fawn. White markings are frequent. The legs and nose are often black. A Jersey or even a Jersey grade can usually be distinguished from most other cattle

*Courtesy of F. D. Stout*

FIG. 202. — GUERNSEY COW, LADY'S HOPE OF MAPLE HILL 44843
Record: 936 lbs. butter fat in one year from 17,444 lbs. of milk.

by the "mustache." This is a ring of light-colored hair around the muzzle, or nose.

**The Guernsey breed.** — This breed (Fig. 202) is somewhat like the Jersey, but the form is generally larger and coarser, and light colors are less common. Guernsey milk

is quite as rich as Jersey. These two breeds are entitled to be called the two principal butter breeds.

**The Holstein-Friesian breed.** — These cattle originated on the rich land near the seacoast in Holland (Fig. 203). They are large, angular, black and white cattle and give

*Courtesy of University of California*

FIG. 203. — A YOUNG HOLSTEIN COW
Record as a two-year-old: 722 lbs. butter fat from 19,985 lbs. of milk.

larger amounts of milk than any other breed. Some cows have yielded twelve gallons in one day. However, the milk is not rich.

**Breeds of hogs.** — There are many breeds of hogs. Among the most popular are the Berkshire, Poland-China, Duroc-Jersey, and Hampshire.

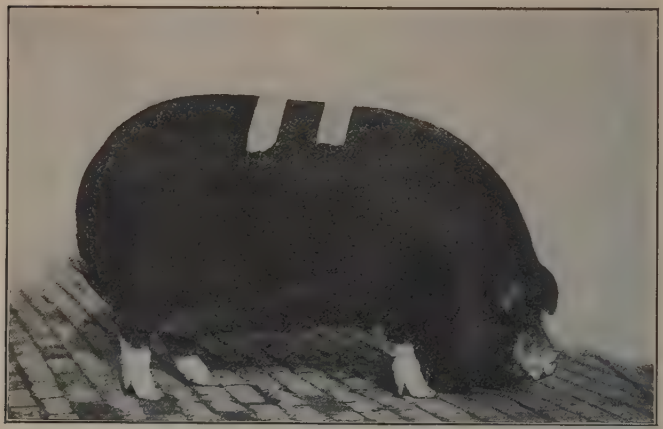


*Photo by Hildebrand*

FIG. 204. — A POLAND-CHINA SOW WEARING THE RIBBONS SHE WON

*Courtesy of U. S. Department of Agriculture*

FIG. 205. — A HAMPSHIRE SOW

Fig. 206. — Club Boys of South Carolina Learning to Judge Live Stock

## SCORE CARD FOR FAT HOGS

| Standard of Excellence | Perfect Score | Student's Score, Hog 1 | Student's Score, Hog 2 |
|---|---|---|---|
| WEIGHT, according to age and breed. Estimated.....lbs., actual.....lbs. | 5 | | |
| QUALITY; hair fine, smooth, covering the body well; bone fine, but strong; animal symmetrical, stylish | 6 | | |
| CONSTITUTION; chest capacious, heart girth large, brisket wide, wide between the fore legs | 12 | | |
| CONDITION, healthy; skin clear of scurf, scales and sores; flesh evenly laid on over the entire body and free from lumps or wrinkles | 3 | | |
| DISPOSITION; quiet, gentle, easy to handle | 3 | | |
| COLOR AND MARKINGS, according to breed | 2 | | |
| HEAD; short, broad, according to breed | 4 | | |
| EYES; full, clear, prominent, expressive | 2 | | |
| EARS; small; fine texture, according to breed | 2 | | |
| JOWL; full, broad, deep, smooth and firm, carrying fullness back to point of shoulder, and on line with breastbone | 2 | | |
| NECK; short, thick, deep, slightly arched, well connected with shoulder | 2 | | |
| SHOULDER; broad, deep and full, carrying thickness well down, and not extending above line of back | 6 | | |
| BACK; medium broad, straight or slightly arched, carrying same width from shoulder to ham | 7 | | |
| LOINS; broad, strong, and full | 7 | | |
| SIDES; full, deep, long, free from wrinkles; ribs well sprung | 6 | | |
| BELLY; broad, straight, and full, indicating capacity | 4 | | |
| FLANK; low, on level with under chest line | 2 | | |
| HAM AND RUMP; rump long, smooth, same width as back; rounding slope from loin to root of tail; ham broad, thick, long, flesh coming well down to hock | 10 | | |
| TAIL; medium length and size, smooth and tapering | 1 | | |
| LEGS AND FEET; medium size and length, straight and nicely tapered; wide apart and well set under the body; pasterns short and strong; feet short, firm, and tough | 10 | | |
| ACTION; vigorous, animated; feet moving forward in straight line | 4 | | |
| TOTAL | 100 | | |

Fig. 207

The Berkshire is a large or medium black hog with white markings on the face, feet, and legs. The face is short and sharply dished. The ears are held stiff or rigid.

The Poland-China is a large black hog with slight white markings on the face and feet. The face is not sharply dished. The tips of the ears droop (Fig. 204).

The Duroc-Jersey is a large reddish hog with shape of face and ears like the Poland-China.

The Hampshire is a large black hog with a white belt (Fig. 205).

### Practice Work and Questions

1. Select a good milch cow of the dairy type. Make a drawing showing the shape of her udder as seen from the side. Compare the size and shape of her udder with that of a cow that never gives much milk.

2. Locate the parts of the body of a good dairy cow, using Fig. 200.

3. A score card for hogs is used in somewhat the same way as for corn (Chapter XX). The score cards for the various breeds of hogs differ but slightly. The score card for fat hogs may be used in practice judging of grade or pure-bred hogs of any of the breeds most extensively raised in the South.

Have any members of this class received instruction, as members of pig clubs, in judging hogs (Fig. 206)? If so, they will be able to show other members of the class the best way to use this score card.

4. Make a survey of the school district to find out the breeds and the number of hogs and their value. Fill out an outline similar to the following in your notebook:

Hog Survey of the District

| Farmer's Name | Hogs | Value | Pigs | Breed | Total Value |
|---|---|---|---|---|---|
| | | | | | |

## CHAPTER XLIX

## CLASSES AND VARIETIES OF CHICKENS

It has been easy to create new breeds of chickens by selection and by crossing. As a result, there are now more than one hundred varieties of chickens. These may be divided into four general classes, according to the use to which each is best suited. These classes are:

(1) The egg breeds
(2) The general-purpose breeds
(3) The meat breeds
(4) The fancy or ornamental breeds

In the chapter on marketing you will learn why it is most profitable for neighbors to adopt the same breed.

**The egg breeds.** — The breeds of this class are so named because they lay more eggs than those of the other kinds. The fowls are small and active. They are poor sitters. Among the leading egg breeds are the Leghorns, Minorcas, and Anconas. They mature early, pullets often beginning to lay before they are five months old. The eggs of this class are usually pure white.

Most breeds of each class are subdivided into varieties named according to color of plumage or shape of comb. In other respects these varieties of each breed are much alike. The Leghorns include eight varieties; among them are the White, Brown, and Buff Leghorns. A Leghorn hen should lay at least 200 eggs in a year (Fig. 208). Minorcas

(Fig. 209) include both black and white varieties. Anconas (Fig. 210) are mottled black and white birds.

**The general-purpose breeds.** — Among the most popular breeds of this class are the Plymouth Rocks (Fig. 211),

Fig. 208. — A White Leghorn Hen That Laid 249 Eggs in a Year

Wyandottes, Rhode Island Reds, and Orpingtons. Six varieties of Plymouth Rocks are the Barred, White, Buff, Partridge, Columbian, and Silver-penciled. Wyandottes are divided into numerous varieties, including the White (Fig. 213) and the Silver-laced. Among Orpingtons are the

White and the Buff. Hens of the general-purpose class, or meat-and-egg breeds, are of medium to large size. They are good layers, although not equal in this respect to the egg breeds. They are good sitters and mothers. Their eggs are usually of a brownish shade of white, and so are those of the meat breeds.

**Meat breeds.**—Among these are included the largest fowls. The principal meat breeds are the Brahma (Fig. 214), Cochin, and Langshan. Each is subdivided into varieties of different colors. All three breeds have feathers on the leg, or shank. The hens lay fewer eggs than do the hens of either of the other classes. These fowls are gentle and good sitters. Their large size renders them less active and less able to search for food than the smaller breeds. Hence, they require more care and food.

FIG. 209. — SINGLE-COMB BLACK MINORCA HEN

**Improving the flock.** — By saving eggs for hatching from only the best layers there will be every year an increase in the number of eggs laid by the flock. Hens have been raised that produced more than three hundred eggs in a year (Figs. 211, 213) by selecting through several generations the best layers and the roosters hatched from eggs laid by the best hens. Those who can not at once have pure-bred

fowls should improve the flock by using only pure-bred cocks.

**Characteristics of a good fowl.** — A good fowl should conform very closely to the standard weight and shape of the breed to which it belongs and have the color of its variety. This shows good breeding. A fowl should likewise show a good constitution. A strong beak, a broad head, a well-formed body, and strong legs indicate a good constitution.

Fig. 210. — Ancona Pullet

**Picking out good and poor layers.** — The profits from most flocks can be increased greatly by getting rid of those hens which lay but few eggs. You can pick out the good and the poor layers by noticing the following points, as shown during or soon after the period of most active laying:

| | Good Layers | Poor Layers |
|---|---|---|
| (1) Moulting or shedding | Late | Early |
| (2) Combs | Red | Pale |
| (3) Space between "lay bones" (See Fig. 212) | Wide | Narrow |
| (4) Color of shanks (in breeds having yellow shanks) | Pale | Deep yellow |

*Courtesy of Oregon Agricultural College*

FIG. 211. — PLYMOUTH ROCK HEN THAT LAID 324 EGGS IN ONE YEAR

Let us see the reasons why these qualities are connected with ability to lay many eggs.

(1) When a hen is moulting, she stops laying. The later she begins to moult the shorter is the time lost from egg laying.

(2) Red, plump combs show an active circulation of blood and the formation of eggs depends on a full supply of blood.

FIG. 212. — SPACE BETWEEN LAY BONES MEASURED BY FINGERS

(3) The egg must pass between the lay bones, so that wide space here (see Fig. 214) shows that the hen is, or has recently been, an active layer.

(4) The coloring matter in yellow shanks helps to supply the color in the yolks of eggs. It is drawn away from the shanks of hens that have recently laid many eggs.

*Courtesy of Can. Exper. Farms*

FIG. 213. — WHITE WYANDOTTE HEN THAT LAID 325 EGGS IN A YEAR

### PRACTICE WORK AND QUESTIONS

1. Write in your notebook the names of all the breeds of chickens that you have seen. What is the color of each? What is the color of the leg or shank?

2. Examine a number of hens in the flock at home or in some neighbor's yard to determine which hens are actively laying, using in turn each of the marks of a good layer mentioned on page 303.

3. Ask the teacher to let the class have an exercise by using some flock near by, in picking out the hens that seem to be poor layers and that should be discarded.

4. If you can secure a copy of "The Standard of Perfection," study the pictures of the various breeds of chickens as to shape, kind of comb, length of back, angle of tail, etc.

5. With fowls of several pure breeds verify the shape differences described in "The Standard of Perfection."

6. Study from live fowls the color of one or two pure bred varie-

FIG. 214. — LIGHT BRAHMA ROOSTER AND PART OF HIS FAMILY

ties; at the same time compare the descriptions as given in "The Standard of Perfection."

7. Secure, if you can, copies of score cards for poultry and for eggs and study them with a view to learning the points that are judged.

## CHAPTER L

## CARING FOR A FLOCK OF CHICKENS

In eggs and in the flesh of her chickens the hen furnishes human foods of the richest quality. The poultry and eggs annually produced in the United States are valued at about three quarters of a billion dollars. Fowls are kept on the farm at but slight expense because much of their feed consists of waste material, such as grass, surplus vegetables, bruised fruit, and spilled grain. Moreover they destroy immense numbers of injurious insects.

FIG. 215. — A HOMEMADE DRINKING FOUNTAIN
*a*, hole in inner tin can.

**Food for poultry.** — Fowls lay and grow best when allowed some exercise. The insects that they catch while ranging in orchard or pasture or field form a most nutritious diet. When fowls are not permitted to range, the food for supplying nitrogen to poultry are the seeds of cowpeas and soy beans, leaves of clover and of all legumes, meat scraps, skimmed milk, and freshly ground bones. These should be in addition to the usual daily supply of corn, wheat, or oats.

Poultry thrives best when furnished with a variety of food and when constantly supplied with green feed. A field of rape, alfalfa, or clover should be grown especially for poultry. When fowls are confined, green feed ought to furnish part of the daily ration.

**Grit.** — Fowls prepare their food not by chewing it like larger animals but by grinding it against grit in the gizzard. Hence fowls that are confined must have an abundance of grit, such as sand, cinders, oyster shells, or any finely divided hard substance. The oyster shells are especially useful to laying hens because, besides serving in the gizzard to grind the food, they furnish lime. Much lime is needed to form the shell of the egg.

FIG. 216. — DUSTING A HEN TO DESTROY VERMIN

**Water.** — Chickens need a constant supply of clean water. A good way to keep it clean is to buy a fountain in which they can not make the water unclean. A homemade drinking fountain may be provided as follows: with a nail make a hole in a can about half an inch from the open end. Fill the can full of water and over it place a pan about two inches deep. Quickly invert both. The water will stand in the pan as high as the hole in the can (Fig. 215).

**Poultry houses, incubators, and brooders.** — A good poultry house should be ventilated but not crossed by draughts of air. Sunshine should be let in to keep it dry and to destroy germs of certain diseases. The roosts should be movable and smooth so as not to afford hiding

FIG. 217. — FLORIDA CLUB GIRLS SELECTING EGGS FOR HATCHING
A lesson by the home demonstration agent.

places for vermin. Some careful poultry breeders build a platform under the roost and a foot or two below. This keeps the floor clean and saves all the manure, which is much richer than that from the larger farm animals.

For raising large numbers of chickens, incubators are

used for hatching eggs and heated brooders for keeping the little chickens warm.

**Destroying vermin.** — The profits from poultry are much reduced by the discomfort caused by lice and mites. When fowls can scratch and roll in the dust, the dust often suffocates the lice. A box of fine, dry road dust, or sifted ashes, should be kept in the poultry house so that the fowls can regularly take their dust baths and thus destroy many vermin. Chicken mites are not all thus killed. Many leave the fowls after tormenting them all night, and spend the daytime on the roosts and walls of the poultry house. Hence, the house ought to be whitewashed frequently with lime wash to which crude carbolic acid has been added. By having the nests movable, these can be brought out of the henhouse at frequent intervals and the straw burned, thus ridding them of vermin. The roosts and coops should be sprayed with a mixture of kerosene and crude petroleum or with either one.

For killing vermin on poultry, each fowl should be treated with a chemical called *sodium fluorid*. The fowls may be dipped in water to each gallon of which three quarters of an ounce of the fluorid has been added, or a "pinch" of the dry material may be placed among the feathers on various parts of the body (Fig. 216). This dry powder is irritating to the throat and so it must be carefully handled.

**Taking care of eggs for market.** — In order for them to sell for the highest price, eggs offered for sale should be sound and attractive. Fertile eggs, that is, those capable of hatching, will not keep long. Hence only infertile eggs should be offered for sale. These are laid by flocks from which the roosters have been removed. Such flocks lay as many eggs as those producing fertile, easily spoiled eggs.

The eggs for sale must be fresh, clean, neatly packed, and uniform in size and color. They should be kept in a cool place. When one is not sure about the freshness or soundness of eggs each one should be held near a light. The sound eggs look clear when thus candled except for the indistinct yolk.

**Eggs for hatching.** — Such eggs should be carefully selected (Fig. 217). They should be fresh, clean, and uniform in size and color. They should come from a pure-bred flock or from one in which at least the male bird is pure-bred and, in addition, a good specimen of the breed.

### Practice Work and Questions

1. How many toes do chickens have? Why are the feet of ducks and geese different from those of chickens and turkeys?

2. Weigh a dozen eggs from your favorite breed, make a record in your notebook, and compare this with the weights reported by your classmates for other breeds.

3. At what time of year do hens lay the largest number of eggs? Is the price then high or low? At what time do eggs sell at the highest prices?

One means of preserving eggs for months from periods when low prices prevail is the following method which you may like to try at home: Add one pint of water glass to about ten pints of water that has been boiled and then cooled. Submerge fresh clean eggs in this solution in a jar placed in a cool dark place. Pupils from any home in which water glass is so used should bring to school a sample of this liquid and of eggs that have been preserved in it. Infertile eggs keep best.

4. **Home project.** — Have you cared for poultry as your home project? If so, bring to class a brief statement of what you found out.

## CHAPTER LI

## HOW FARM ANIMALS USE PLANTS FOR FOOD

Has not every boy or girl in this class some pet—a pig, a calf, a colt, or some other animal? If so, each of you should be able to determine the kind and amount of feed that it requires when you have learned what use animals make of the different substances contained in their usual feedstuffs.

**Composition of feeds.** — As a first item in learning to feed the animals that most interest us, we need to learn what kinds of substances are contained in the common feeds. That is found out by a chemist, when he analyzes them, that is, takes them apart. His work shows us the *composition* of a food, or the kinds of substances in it and the proportion or percentage of each. Then he feeds animals on weighed amounts of feed and analyzes everything that the animal body gives off, and thus tells us what percentage of each substance in the feed is digested. Appendix II is a table showing the amount of each kind of digestible substance, or nutrient, in the feeds most used in the South. We shall now consider some of the principles on which the profitable feeding of all farm animals depends.

**Plants constitute the main source of food for farm animals.** — Plants form the natural food of the animals of the farm. Animals can not feed on the minerals in the soil or on the carbon dioxid in the air; the plant lives on both.

The chief use of the plant to man is in changing the minerals from the soil and the carbon dioxid from the air into substances fit to nourish man and his servants, the domesticated animals.

**Similar substances in bodies of plants and animals.**— The same classes of substances are found in the bodies of plants and animals. These are water, ash, and protein (that is, materials containing nitrogen). Each of these substances in the plant goes to form somewhat similar matter in the animal body. But plants contain substances not found in the flesh of animals; these are starch and sugar. Yet starch and sugar are among the most important foods of animals. Instead of adding these to its own body unchanged, the animal converts the starch and sugar from plants into animal fat or uses them as fuel.

**Ash.** — The part of the dry matter of plants or animals that will not burn is called ash. There is generally an abundance of this in the common foods to supply all that animals need. Pigs fed on corn alone without any pasturage may be helped by giving them wood ashes, which aid in the formation of their bones and in other ways. Fowls also often make use of ash in the form of ground bone and the like.

**Protein.** — In plants and animals most substances containing nitrogen are called proteins. Forms of protein are lean meat, white of egg, and the curd in soured milk. The protein of plants is used by the animal to make lean meat, muscles, blood, and curd in milk. Men or farm animals doing heavy work require an abundance of this substance, as do cows when giving much milk. Among the foods richest in protein are cottonseed meal, peanut meal, and both the hay and the seeds of leguminous plants. The seeds of all other plants contain a smaller proportion of protein.

**Fuel for heat and force.** — The animal body is a machine with much work to do. Even an idle horse expends some force or work in the circulation of the blood and the digestion of food. All the work the horse has to perform increases the force or energy he must expend. Hence the horse needs to use a part of his food to produce force or motion

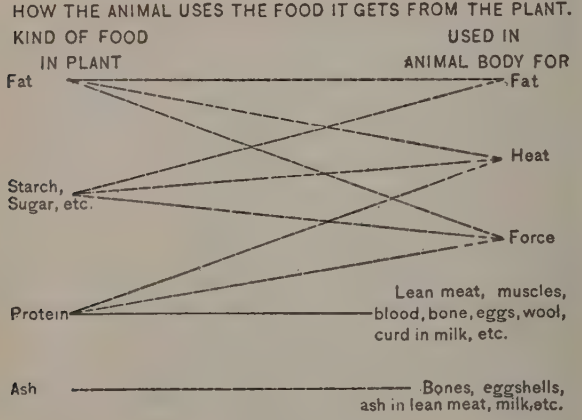

HOW THE ANIMAL USES THE FOOD IT GETS FROM THE PLANT.
KIND OF FOOD IN PLANT
USED IN ANIMAL BODY FOR
Fat
Fat
Heat
Starch, Sugar, etc.
Force
Protein
Lean meat, muscles, blood, bone, eggs, wool, curd in milk, etc.
Ash
Bones, eggshells, ash in lean meat, milk, etc.

FIG. 218

just as much as a steam engine needs burning coal to furnish power. An animal needs some food to serve as fuel to keep the body warm. Thus a part of the food is consumed, or slowly "burned," in the body in order to be changed into heat and force. Among the substances that serve as fuel to produce heat and force are starch and sugar. Starch, sugar, and the coarse fiber of plants are called carbohydrates.

This is because they consist of carbon and hydrogen, in addition to oxygen. The carbohydrates constitute the chief fuel of the animal body.

**Fat.** — Fat or oil is abundant in the seeds of some plants, as in cotton seed, flaxseed, soy beans, and peanuts. The fat of plants can be used by the animal to make fat in the animal body. Fat in the food is also used for fuel to produce heat and force. Indeed one pound of fat when burned makes about two and one fourth times as much heat as one pound of carbohydrates.

FIG. 219. — EFFECTS OF BALANCED RATION (on right) AND UNBALANCED RATION (on left)

**Fattening.** — An animal that digests more carbohydrates than it needs for heat and force changes the surplus into fat, which it stores in its body or adds to its milk. No fattening can occur until after all food necessary to do the work of the animal's body has first been provided.

Young animals require less food than older ones to increase their weights equally. It pays better to fatten a hog less than a year old than one nearly two years old.

**Balanced ration.** — A ration is a supply of food for an animal for one day. It is called a *balanced ration* when it contains just the proportion of digestible proteins to the carbohydrates and fats that tests have shown to be best for that particular kind of animal. The proportion is called the *nutritive ratio*. It is obtained by multiplying the fat by 2¼, adding this product to the carbohydrates, and dividing this sum by the quantity of protein.

The daily ration must be well balanced in order to supply enough of each class of nutrients. If the ration is much too low in the proportion of protein, the animal can not eat enough of the feed to furnish all the protein required for growth or milk production.

The skillful feeder secures the desired balance, or proportion between nutrients, by mixing definite amounts of feeds rich in protein, such as peanut meal, with other feeds deficient in protein and excessively rich in carbohydrates, such as corn (Fig. 219).

### Practice Work and Questions

1. Feeds having a nutritive ratio of 4.5 or less are called nitrogenous; those having a nutritive ratio of between 4.5 and 6.5, balanced; and those of which the ratio is above 6.5 are called carbonaceous (usually starchy) feeds. Select from the table in Appendix II a list of (*a*) three nitrogenous, (*b*) three balanced, and (*c*) three carbonaceous feeds, writing these lists separately in your notebook.

2. Calculate the nutritive ratio of corn. The steps which you should write in your notebook, after looking up the figures, are as follows.

4.6 lbs. of fat × 2¼ = 10.35
carbohydrates = 67.8
Total = 78.15
78.15 ÷ 7.5 = 10.4, nutritive ratio

Calculate in the same way the nutritive ratio of some other feed that is fed to animals in which you are interested.

## CHAPTER LII

## FEEDING A PIG

Many a boy has made a pig his favorite pet and a very profitable pet it has often proved. Are you a member of a pig club, or of any other club in which a boy or girl raises a pig or a calf to be his or her "very own"? Young persons through their pig clubs have done much in making pure-bred hogs popular in the South. It costs so little to make a start in improving the hogs on any farm that scrubs or razorbacks ought soon to disappear. Pure-bred hogs and grades mature at a much earlier age than scrubs and grow to a much larger size.

**Essentials in raising hogs.** — A pig makes a pound of growth out of less food than does any other animal; that is, out of four to five pounds of concentrated feed, skillfully fed. The raising of hogs for home use and for sale should become one of the main lines of farming in the South. Essentials to the highest success in raising hogs profitably are (1) good fences, (2) pastures, (3) crops grown especially for hogs to gather, such as soy beans, peanuts, and sweet potatoes, and (4) such intelligent care as will keep the animals healthy.

**Age of swine affects use of food.** — Somewhat different combinations of feeds are required by (1) sucking pigs, (2) weaned shoats, and (3) large fattening hogs. Moreover young animals make a pound of growth on less feed than older ones. The average of many tests shows that pigs

lighter than fifty pounds make a pound of growth from about three pounds of suitable grain and that about five pounds of such feed is required to produce the same result when the hogs weigh about 200 pounds. The table in the Appendix (page 362) shows how many pounds of nutrients are required for the best growth of swine of different sizes. (See Figs. 220, 221.)

*Courtesy of Texas Agricultural Experiment Station*

FIG. 220. — EFFECTS OF BALANCED RATIONS

Two pigs on right had a balanced ration; smaller pig of same age received only a starchy grain.

**Principal concentrated feeds for pigs.** — Among these are corn, shorts, rice polish, peanut meal, and tankage. *Corn* is rich in carbohydrates, but it contains too small a proportion of protein to serve as the sole food of growing pigs or sows. *Shorts* (or middlings) consist of a part of the material removed from the wheat grain in the making of flour. This feed contains more protein than does corn and

also considerable carbohydrates. Shorts are suitable for mixing with corn but usually make an expensive feed. *Rice polish*, a fine powder removed from grains of rice in the manufacture of commercial rice, is similar in composition to corn. *Peanut meal* is very rich in protein. *Tankage* is a mixture of blood and other by-products obtained from the carcasses of animals. It is the richest protein of all common feeds and should usually make up not more than one tenth

Fig. 221. — The Sow Needs an Abundant Balanced Ration to Make Milk

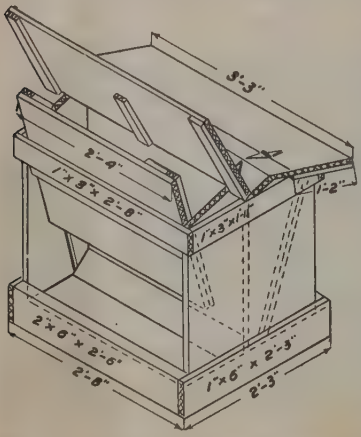
of the concentrated ration. Seeds of soy beans, cowpeas, and other legumes are extremely rich in protein.

**Feeding sucking pigs.** — For the first two or three weeks the milk of the mother, if she is well fed, is sufficient for sucking pigs; then they should be offered a little shelled corn.

The best extra feed is skimmed milk or buttermilk, the dry matter of which is especially rich in protein and ash. With it should be fed corn meal or corn. If milk can not

be secured a good ration for sucking pigs is a mixture of corn and shorts or of three fourths corn and one fourth high-grade peanut meal. To each of these rations may be added not over one tenth its weight of tankage.

**Management of sow and pigs.** — A sow should bring two litters of pigs a year, one in the first days of spring and the other in the early part of the fall. The pigs should be weaned when ten to twelve weeks old. A separate trough should be provided for the little pigs both before and after weaning. This should be located inside of a pen from which the larger shoats and hogs are excluded.




*Courtesy of Mississippi Agricultural Experiment Station*

FIG. 222. — PLAN FOR MAKING A SELF-FEEDER

In order that nursing pigs may make rapid growth (Fig. 221), the sow must be fed liberally. Her ration should include pasturage and a full supply of concentrated feed. A mixture is usually best, such as corn and skimmed milk, or corn and tankage, or corn, peanut meal, and tankage.

Each sow with her litter should have a separate pen. A guard rail should be nailed around the sides of the pen in which the pigs are farrowed, or born, in order to keep large sows from lying on some of the pigs.

**Feeding and caring for growing hogs.** — For the first

few weeks after weaning, it is best to increase the amount of feed offered the pigs but not to make an extreme change in the kind. After weaning the pigs, the cheapest feeds are pasture plants and crops grown for the hogs to harvest, such as peanuts, soy beans, dwarf Essex rape, and sweet potatoes. Some concentrated feed is usually needed to supplement ordinary pastures, such as a half-ration of corn together with five to ten per cent of its weight of tankage. When hogs are rooting up sweet potatoes, a starchy feed, a good addition is peanut meal or tankage. A self-feeder (Fig. 222) saves labor by supplying the concentrated feed as rapidly as it is eaten.

If the animals are "hogging off" a field of soy beans, the richness of this feed in nitrogen should be balanced by feeding corn. The cheapest way to feed corn to hogs is to let them harvest this crop, together with the soy beans or other legume that should be grown in the same field as a catch crop.

In another chapter is discussed the subject of pastures, without which the cheapest pork can not be produced.

**Peanuts as a feed for hogs.** — On the sandy lands of the southern part of the Cotton Belt, the cheapest pork has been produced by growing peanuts for hogs to consume in the fields. The addition of a little tankage has proved beneficial in some experiments in Alabama. Peanuts make a soft flesh, and peanut-fed hogs have generally sold at a lower price than others, especially when shipped to Northern markets.

**Fattening hogs in the South.** — During the few months just before being slaughtered, hogs that are nearly grown may be fed a ration more starchy than that required by growing swine. For large fattening hogs corn may well be

the principal concentrated feed, with small additions of tankage or peanut meal. Hogs raised chiefly on peanuts afford a firmer quality of pork if taken off six to eight weeks before the date of slaughter and fed on starchy rations made up largely of corn; but the higher price paid for hogs thus finished has sometimes been insufficient to justify the extra expense.

**Supplying hogs with ashes.** — Some feeds do not contain enough ash or mineral material for the best growth of the pig or of the brood sow. Among these are corn, peanuts, and velvet beans. A mixed diet of concentrated feeds and pasturage usually supplies more ash. It is well to keep in all hog lots a box, from which the hogs may eat whenever they like, containing a mixture of wood ashes, salt, charcoal, and other ash material.

**Keeping hogs healthy.** — Hog cholera is caused by disease germs thrown off from the bodies of infected hogs. It is spread by buzzards, running water, or even the feet of men and animals. Cholera can usually be prevented by not allowing the hogs to range outside of their pasture, and by keeping out all animals that have been on a farm where cholera has recently prevailed. It is safest for hogs not to drink from a stream that originates beyond one's own property.

Hog cholera is controlled by inoculation. One method makes a hog permanently resistant to this disease. The other method renders a hog safe against cholera for only a few months but is somewhat safer for use by an untrained person. When cholera breaks out in a neighborhood, a veterinarian or county demonstration agent should be consulted at once.

Much of the sickness of hogs is caused by worms and

other enemies that have multiplied in sick animals. These are taken into the bodies of healthy hogs, especially through impure drinking water. Hence the health of hogs is safeguarded by providing a supply of clean water, by promptly removing any unthrifty animal, and by keeping the floors where hogs feed and sleep clean and disinfected by occasional washing with creolin or other disinfectant. Lice are killed by greasing the hogs with crude petroleum or by dipping or washing them in water containing a disinfectant.

### Practice Work and Questions

1. If a pupil can secure plenty of skimmed milk for a pig weighing about 100 pounds (which thrives best when the nutritive ratio of the ration is about 1 to 5), find in the table in the Appendix two feeds either of which would balance the ration.

2. A farmer has shoats weighing 100 pounds on a field of ripening peanuts. Find in the table three feeds, either of which would separately balance the ration.

3. A boy was feeding his pig weighing about 125 pounds, using equal weights of shorts and peanut-meal feed (including the ground-up hulls). Find out from the table what concentrated feed should be substituted for the shorts in order to supply the larger proportion of carbohydrates needed by shoats of this size.

4. If $5\frac{1}{2}$ pounds of corn will produce 1 pound of pork, how many pounds of pork may be produced from a 40-acre field yielding an average of 27.5 bushels to the acre?

5. If hogs sell for $7\frac{1}{2}$ cents a pound and corn sells for 1 cent a pound (56 pounds to a bushel), how much will the farmer make from cultivating such a 40-acre field of corn?

## CHAPTER LIII

## FEEDING THE COW AND HER CALF

The products of the cow, milk and butter, are among the most important of human foods. Without them children would grow up puny and undersized, the sick would more often fail to recover, and even strong men and women would be less able to accomplish hard tasks.

**Vitamines.** — The name "vitamines" is given to substances recently found to exist in very small quantities in certain foods but that have not yet been separated. They are known by their effects in promoting growth and vigor. There are three recognized kinds of vitamines. The first is found in butter fat and hence in whole milk and cream. It is also contained in the yolk of eggs and in some other foods. The second is present chiefly in the leaves of plants and also in fresh vegetables, fruits, and parts of seeds. A third is especially abundant in oranges and lemons. A diet composed of several foods is more likely to afford all the necessary classes of vitamines than is a single food. Doctors and feeders of live stock are making increasing use of discoveries about vitamines. Their presence in the fat of milk helps to explain why milk, cream, and butter have such remarkably beneficial effects both on human beings and on young or unthrifty farm animals.

**Feeding a baby calf.** — The milk of the cow is the best food for the newborn calf, but dairymen have found it more

convenient to take the calf entirely away from its mother, either as soon as born or a few days later (Fig. 223). Its mother's milk is fed to the calf for the first few days; and then whole milk from any cow for a few weeks. However, as whole milk can usually be sold for more than its feeding value, the dairyman substitutes skimmed milk, which becomes the chief support of the calf after it is a few weeks old.

FIG. 223. — CALVES AT FEEDING TIME
Notice wooden slats forming stanchions.

Skimmed milk is poor in fat and vitamines, and so it is necessary to add some solid foods that are fairly rich in these. A good addition is shelled corn or shorts. The calf should receive the best hay made from alfalfa or some other legume. It also needs tender pasture plants. Skimmed milk must be warmed for calves and fed in just the correct quantity. The buckets from which it is fed must be scalded every day and kept as clean as other dairy vessels.

**Care of the growing heifer.** — The feeding of skimmed milk should continue until the calf is about six months old. The ration of concentrated feed should not be cut off suddenly when feeding on skimmed milk ceases. Good pastures of mixed legumes and grasses afford the best and cheapest ration for the growing heifer. Grain or meal should be added whenever the pasturage is insufficient. A stunted heifer never makes so productive a cow as she would have made if she had been kept continuously growing.

**Amount of feed.** — The force or energy that a good dairy cow exerts in producing a full flow of milk is about as great as that of a horse at heavy work. Therefore, she should be given all the feed she is able to digest. Moreover the cow must first use her food to maintain life. Only the surplus food is used in making milk.

A good rule is to give a cow while in milk as much of the best hay or silage as she will eat and then one pound of concentrated feed for every three pounds of milk that she produces. Thus a cow giving three gallons of milk (about twenty-five pounds) would receive about eight pounds of concentrated feeds daily. When she is on a good pasture, about half this amount may be sufficient.

**Concentrated feeds.** — Among the most suitable of the feeds rich in protein are cottonseed meal, peanut meal, velvet beans, shorts, wheat bran, and cotton seed. Cottonseed meal and cotton seed make firm butter. Velvet beans may be fed in their natural condition in the pod, although it often pays to grind them or to soak them in clean water. It is best to combine them with some other concentrated feed. Corn and oats are rich in carbohydrates, and it is best to grind these feeds for dairy cows.

**Coarse feeds.** — Pasturage of mixed legumes and grasses

produces milk at lower cost than does any other diet. Next comes silage and the hay from legumes grown on the farm. Hay from alfalfa, cowpea, Lespedeza, and all other legumes is rich in protein when so cured as to retain the leaves.

Hay made from grasses is lower in protein, but the best grades of these hays are good sources of carbohydrates. Among the most popular grasses for hay are crab grass, Johnson, and Sudan. Oats cut when the seeds are in the milk stage make good hay. The hay is richer and the yield larger when vetch or crimson clover is sown with the oats.

**Silage.** — Cows give most milk when fed on a ration made up partly of succulent material, such as pasture plants or silage. Silage consists of green crops cut into bits and kept in a tight building called a silo. In the silo some fermentation occurs, which causes the succulent feeds to keep in sound but soured condition.

Silage is usually made from sorghum or from corn placed in the silo while still green but after the grains have begun to harden. Corn makes the richest silage, but the yield from sorghum is greater. Both corn and sorghum silage are low in protein.

A dairy cow will usually consume about thirty pounds of silage daily, besides other feeds. Coarser plants may be used for silage than for hay and so a larger yield of food material can usually be obtained from an acre of silage crops than from one of hay.

**Balancing the cow's ration.** — Many tests have proved that a dairy cow makes the largest quantity of milk when her ration contains enough digestible protein for it to make up at least one sixth or one fifth of the total weight of the digestible material consumed. That is, a good dairy ration has a nutritive ratio of 1 to 5, or 1 to 6.

If the roughage to be fed is silage, grass hay, or other feed low in protein, we must correct this by making the concentrated feed consist largely of cottonseed meal or peanut meal. If the chief roughage is a good grade of hay from any leguminous plant, we may use considerable corn or cotton seed in the grain ration.

### Practice Work and Questions

1. Copy in your notebook from the table in the Appendix the figures that show the amounts of digestible nutrients required by (*a*) young calves weighing about 150 pounds, (*b*) a large cow giving three gallons (about 25 pounds) of milk daily.

2. A certain large cow in full flow of milk needs 2.4 pounds of digestible protein daily; find how much of this is afforded by five pounds of cottonseed meal (see table in Appendix).

Does any member of this class desire to calculate the amounts and kinds of the additional feeds needed to complete this ration? Ambitious pupils can do this by using the figures in the table and by asking the teacher for the helps printed in the Teacher's Handbook, a manual for teachers of this textbook.

3. Copy from the table the names and nutritive ratios of the ten feeds that you think best suited for feeding calves and cows in your community.

4. Find the cost by the ton and by the hundred pounds of each of the feeds fed to three different kinds of farm animals.

Also find the number of pounds of each of the feeds fed to these animals and compute the cost of the rations for one day.

5. **Home project.** If you would like for your home project to be a dairy project, talk to your parents about it. Possibly they would let you take entire care of the feeding and milking of one good fresh cow for one month or longer and let you have for your own whatever profit you could show above the profit the same cow has afforded before. This means that you will keep a record of the milk produced and the feed used and so begin to learn bookkeeping.

## CHAPTER LIV

## THE PRODUCTION AND CARE OF MILK

There are many ways for boys and girls to add to the profit which their parents obtain from the home farm. One of the easiest and most interesting is to play detective among the cows. Would you not like to find which are the thieving

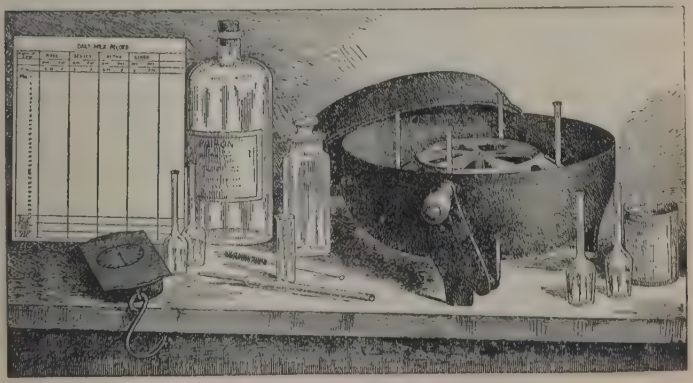


Fig. 224. — Babcock Milk Tester and Outfit

cows, that is, those not producing enough butter fat to pay for their feed and care?

**The Babcock milk tester.** — Dairymen who test the milk of each cow by means of a Babcock milk tester (Figs. 224, 225) sometimes find that half the cows in their herds are not paying for their feed and care. By selling the inferior

cows for beef and keeping only those that make a large yield of butter fat, a dairyman sometimes doubles his net profits.

**Recording the amount of milk.** — If you really wish to help your parents to double their profits from cows, you will not stop at learning to make an accurate test of the richness

FIG. 225. — SCHOOLBOYS TESTING SAMPLES OF MILK

of each cow's milk. Even cows of the same breed differ greatly in the amount as well as in the richness of their milk. You should weigh the day's milk of each cow at least once a month. It is easy to write the figures on a ruled sheet of paper tacked on the barn wall. There should be space for the date and one column for each cow. What fun it is to foot

up the figures and really get acquainted with the true worth of every member of the herd!

On one dairy farm where the milk was weighed only about once a month, there was a large cow that the farmer had thought was better than any other of the forty cows in the dairy. But when monthly weighings were made, she

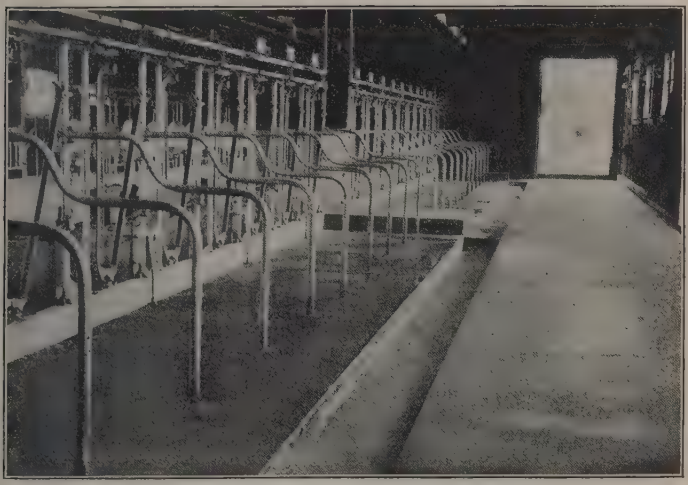


Fig. 226. — Interior of a Sanitary Dairy Barn

was found to go dry in less than seven months and to give poor milk also. Her place was taken by a more profitable cow. In the same herd was another cow of plain appearance that the owner had planned to sell for beef. When monthly records were kept this one was found to be a valuable animal.

**Care of the cow.** — No other farm animal pays so well

as the dairy cow for good treatment and thoughtful care. The time of feeding and milking should be the same from day to day. A cow's yield of milk shrinks if she is excited. The teats should be thoroughly stripped; for the last milk is about ten times as rich in fat as the first few ounces drawn. Moreover leaving milk in the bag causes the cow to dry up and may cause injury to the udder.

**Keeping the milk pure.** — Milk is formed from the blood which circulates through the udder in exceedingly small blood vessels. While forming in the udder, milk of a healthy cow contains no germs. But as soon as it is drawn, germs fall into it. A dirty udder, a dusty stable, dirty hands, and poorly cleaned milk vessels are the most common means of adding unwelcome germs to milk.

FIG. 227. — OPEN AND SMALL-TOP MILK PAILS

Before milking, dust and the loose hairs on and around the udder should be removed by wiping with a damp cloth. The stables must be kept clean and well littered so that the cow's udder and body may not become soiled. To avoid getting dust and germs in the milk, it is better to feed hay or other dusty feed after milking or else a long time before.

The milk pails, strainers, and all other vessels must be kept clean by careful washing and the use of scalding water or steam after each milking. Be sure to clean thoroughly the seams and rough places in metal milk vessels.

These hiding places may be crowded with germs if any of the dried milk is allowed to adhere. Sunning helps to clean milk vessels, for sunshine is a great enemy of germs. Neither milk nor empty milk vessels should ever be left in a room where there is sickness. Germs of human diseases sometimes enter milk by this means or by the use of impure water used in washing the milk vessels. If the milk pails have partially covered tops, much of the germ-laden dust will be excluded (Fig. 227).

**Cooling.** — Milk or cream should be cooled as soon as possible, for germs do not multiply so rapidly in a cold temperature as in a warm one. One means of quickly cooling milk or cream consists in putting it in tall slender cans and placing these in cold water.

### Practice Work and Questions

1. Wild onion or garlic ruins the milk and cream during certain months. Do you know at what time this occurs? If cows are able to get rid of this flavor in about five hours, at what time of day should the cows at your home be taken out of such a pasture to avoid garlic flavor in the evening's milk?

2. At another time of year the milk and butter from cows grazing on certain pastures are bitter, because the cows then eat some of the yellow-flowered bitterweed. Do they eat it chiefly when it is well-grown or when it is about the height of the pasture grasses and clovers? Why?

3. The Babcock tester shows that Blossom's milk contains 4 per cent of butter fat and Pet's 5 per cent. Blossom gives 5,000 pounds of milk a year and Pet 4,500. How many pounds of butter fat does each produce in a year?

4. Ask your parents to help you estimate how many gallons of milk the best cow at your home produces in a year and write the answer in your notebook. This is equal to how many pounds at 8.6 pounds to the gallon?

## CHAPTER LV

## MAKING BUTTER

The fat in milk is in the form of very small, round particles, called *globules*. Since fat is lighter than milk, the fat globules rise to the surface, forming the cream. They rise more completely if the milk is cooled promptly after milking. Hence milk is usually promptly poured into shallow pans or quickly cooled in deep cans placed in cold water.

**Separating cream.** — Any method of removing the fat globules that depends on their rising to the surface leaves many of them entangled in the skimmed milk. When shallow pans are used, about one fourth of the fat may be lost in the skimmed milk. However, the cream separator (Fig. 228) removes nearly all the fat. It does this by the rapid revolution of the metal bowl through which the milk is passing. The bowl revolves thousands of times every minute. The rapid motion throws the heavier part of milk to the outer edge of the bowl, from which it runs out as skimmed milk. The cream, being lighter, is crowded nearer the center of the bowl and overflows. The use of a cream separator greatly increases the amount of butter produced. The cost of a separator has often been paid by the extra butter obtained within a few months even from as few as six cows. It saves time and leaves the skimmed milk in a fresh condition.

Farmers who live near enough to a creamery to ship

cream usually find it better to let the making and selling of butter be done by the creamery. The shipping of cream

*Courtesy of the De Leval Separator Co.*

FIG. 228. — ONE OF THE MODELS OF HAND SEPARATORS

produced by the separator relieves the members of the family of much work.

**Ripening cream for churning.** — While many kinds of germs are harmful to milk, one kind is needed in milk or

cream intended for making butter. This is the lactic germ, the one that produces the ordinary souring of milk or cream. When numbers of these germs get into milk kept at a mild temperature, they change the sugar in it into a pleasant acid, called lactic acid, the flavor of which is found in buttermilk. This acid changes that part of the milk which contains nitrogen into the somewhat solid curd and makes it easier for the churn to separate the fat. Cream is soured, or ripened, before it is churned.

If the milk or cream is kept too cold before churning, other germs that can endure more cold increase more rapidly than the helpful lactic germs, thus giving an unpleasant flavor to the butter and buttermilk. On the other hand, if the cream is kept very warm, souring occurs very quickly and the butter is soft and inferior. A good temperature at which to ripen, or sour, cream at home is 65 to 75 degrees Fahrenheit. This is about as warm as the air of a comfortably heated living room in winter. In some dairies the cream is cooled to about 50 degrees. Since the lactic germs multiply slowly in cold milk or cream, it may be necessary in cold weather to add an extra supply of these germs. The addition of a little well-flavored buttermilk from a previous churning is one way to hasten the ripening of milk or cream in cold weather.

The flavor of butter is chiefly due to the kind of germs in the ripening cream. To make sure that every lot of butter shall have a good, uniform flavor, some dairymen add a prepared *starter* containing the particular germs that will produce the desired flavor.

**Churning.** — A good temperature for the cream in the churn is about 60 degrees Fahrenheit if the cows are fresh in milk and are not fed on cotton seed or cottonseed meal.

If these foods are used, raise the temperature within the churn to some point between 63 and 68 degrees. Much warmer cream can be churned, but the butter is then soft and mixed with the curd of the milk. Such butter sells for a very low price and soon becomes rancid. Moreover, if the cream is warm when churned, much of the fat is left in the buttermilk. A dairy thermometer costs little and often saves many an hour of work and many a pound of butter.

Sometimes, when butter will not come, it is because the cream is not sour enough or because the churn is too full. The best churns are those that revolve, and these should not be more than one third or one half full. Green feed for the cows makes the cream easier to churn and gives to the butter an attractive yellow color. Sometimes, when the butter comes but will not gather, churning can be hastened, but the buttermilk ruined, by adding a little salt.

**Handling the butter.** — The churn should be stopped when the grains of butter are about as large as kernels of wheat. Then draw off most of the buttermilk and add cold water to harden the butter. Later wash the grains of butter thoroughly in cold water. Add fine dairy salt while working it on the butter worker. It is usually best to work it twice. When coloring is added this should be placed in the churn before churning begins. A uniform color, neat prints, and careful wrapping in special oiled paper greatly increase the selling price.

### Practice Work and Questions

1. If we assume that one pound of butter fat is mixed with enough water, curd, and salt to make $1\frac{1}{8}$ pounds of butter, what would be the number of pounds of butter produced annually by each cow mentioned

in Exercise 3 of the last lesson? With butter at forty cents a pound, what is the value of the yearly butter product of each of these cows?

2. Find two clear small bottles of exactly the same shape and size. Fill one with the first few ounces of milk and the other with the last milk, or strippings, from the same cow. Pour out from either bottle until the milk stands at the same height in each. Stand the bottles in cool water for twenty-four hours. Then measure the thickness of the layer of cream on each; record the figures in your notebook and report them to the class. It is still better to get someone who has a Babcock tester to make a test of your samples of first milk and of strippings.

3. **Home project.** What fun there would be in making a Babcock test if the school owned a tester! Possibly some day some pupil's parent will make this gift to the school. If there is a Babcock tester in the neighborhood the owner may be willing to bring it to school and there test samples of milk brought in by the pupils.

The teacher may decide that there are enough pupils coming from homes where butter is made to hold a dairy show Friday afternoon. What pupils will bring to it a package of butter churned and worked by themselves?

4. Make a survey of the dairy cattle of the school district. Fill out an outline like the following in your notebook:

Dairy Cattle Survey

| Name of Owner | Breed | Number of Cows | Gallons Produced | Pounds of Milk (Multiply gallons[1] by 8.54) |
|---|---|---|---|---|
| | | | | |

[1] A gallon of milk weighs 8.54 pounds.

5. If there is a creamery in your neighborhood, get permission to visit it and make a written report of the various processes that you saw being carried on.

6. **Home project.** Ask permission at home to try out any methods suggested in the chapter that are not now being used there in the making of butter.

## CHAPTER LVI

## FARM IMPLEMENTS AND MACHINERY

Machinery now does much of the work on the farm once performed by human hands. Especially in grain growing the work has been lightened and the cost of production greatly decreased.

**Machinery for the grain grower.** — The seeds and fer-

*Courtesy of U. S. Department of Agriculture*

FIG. 229. — A SELF-BINDER

tilizers are sown with a *grain drill*. The *self-binder* cuts and binds as much in a day as many men with cradles could have done fifty years ago. On some of the extensive grain fields of the West even the self-binder is displaced, and its work is done by still more powerful and effective machinery. The

Fig. 230. — A Tractor Pulling Disc Harrows

*combined harvester*, drawn by a tractor or horses, cuts the grains from many acres in a day and, as it moves along, threshes and sacks the cut grain.

**Tractors.** — Tractors (Fig. 230), or pulling engines, are profitably employed on many Southern farms. They are most useful for plowing and harrowing. Their special ad-

vantages over teams consist in accomplishing a large amount of work in a short time and in requiring no expense for fuel while they are idle. Tractors do not entirely displace work animals but reduce the number of teams required on a farm. For the best use of tractors there is need for the drainage of

*Courtesy of U. S. Department of Agriculture*

FIG. 231. — LOADING HAY DIRECT FROM WINDROWS

wet spots and for the construction of broad terraces on hillsides.

**Haymaking machinery.** — In hay growing also invention has made the labor much less burdensome than it was in earlier years. There are *horse rakes* for collecting the hay into windrows, *tedders* for turning and more rapidly dry-

*Courtesy of International Harvester Co.*

FIG. 232. — STACKING HAY BY MACHINERY
Note sweep rake in the foreground and stacker lifting a load.

ing it, and *sweep rakes*, drawn or pushed by horses, for collecting hay from the windrows and carrying it short distances to the barn or stack. These sweep rakes save the work of loading a wagon. Where the distance is greater, so that hauling on wagons becomes necessary, there are *hay loaders* which save pitching the hay. These are hitched

Fig. 233. — A Bundle-carrying Corn Harvester

beh nd the wagon, and, as the wagon and loader are drawn along, the hay is elevated from the windrow to the wagon (Fig. 231).

At the barn or stack one or two horses, hitched to a *hay carrier*, may lift the hay from the wagon to its place in the barn. Where sweep rakes are used to bring the hay to the stack, these deliver their burdens to a *hay stacker* (Fig.

232). Then the stacker, by means of horse power, raises the load to its position on the stack.

**Machinery for corn, sugar cane, and rice.** — The corn grower also has profited by the mechanic's art. He uses *corn harvesters* to cut and to tie corn, and *shredders* to sepa-

*Courtesy of U. S. Department of Agriculture*

FIG. 234. — A RIDING CULTIVATOR

rate the ears from the stalks, to remove the shucks, and to tear the forage into bits suitable for most convenient use as feed or bedding. Even a bundle-carrying corn harvester (Fig. 233), a shocking machine, and a machine for pulling the ears have been invented.

The rice grower uses the grain drill, the self-binder, and other machinery like that employed in grain farming. The sugar planter is testing cane loaders, and cane harvesters are engaging the inventor's attention.

**Labor-saving implements on cotton farms.** — The cotton farmer has made less general use of labor-saving machinery

*Courtesy of U. S. Department of Agriculture*

FIG. 235. — THE WRONG WAY TO STORE COTTON

than the grain and hay grower. It is possible to grow cotton profitably with a few very inexpensive implements and hence a beginning may be made in cotton culture by one who has very little capital. But here too it pays to utilize labor-saving machinery and the implements which make possible the most thorough preparation and cultivation. Most cotton farms on which several horses or mules are worked

need a disc plow, large "turning plows," a spike-tooth harrow (and often others), a weeder, and the best cultivators. Riding on one of these labor-saving implements, one intelligent man often does well the work that several did while walking behind smaller implements. Machinery for poisoning cotton-boll weevils is also in use (Fig. 181).

The invention of the cotton gin was the greatest factor in building up the cotton industry of the South. Likewise a great cheapening of the cost of producing cotton will result when a cheap, simple, and durable cotton picker shall be on the market. There have been successful public tests of several different *cotton pickers*.

**Farm buildings.** — Not only are implements needed in farming, but also convenient farm buildings for sheltering implements, live stock, and crops. A building too often not found on a cotton farm is a shed under which to store machinery and bales of cotton. A shelter causes tools to last longer and cotton to bring the highest price.

### Practice Work and Questions

1. Write in your notebook a list of the kinds of plows and harrows you have seen.

2. Ask your parents to tell you some of the farm implements that they consider most useful. Write this list in your notebook and also what each is used for.

3. What farm or household work needs some new inventions to make it lighter?

4. Ask permission of your parents to take to school for examination in class agricultural papers containing pictures of farm implements and any catalogues of machinery that you can find.

5. **Home project.** Make a list of all the labor-saving machines or devices that are used in your home.

## CHAPTER LVII

## EARTH ROADS

Good roads make country life more attractive. They also make possible in the country good schools, churches, and social gatherings. They soon pay for their cost in the

*Courtesy of U. S. Department of Agriculture*

FIG. 236. — JUNCTION OF GOOD ROADS IN TENNESSEE
Note the number of bales on the wagons.

labor of men and teams saved by hauling with a few loads over good roads the same weight that requires many trips

over bad roads. Good roads pay also because they save teams and wear and tear on vehicles. Improving a road increases the value of the land near it.

**Location of roads.** — A road is no better than its worst part. The load hauled is as large as the team can pull up the steepest hill or over the most boggy place in the road. Hence the first work in improving a road ought to be to improve the worst places. It pays to change the location of a road to avoid very bad hills. Roads ought not to go straight up steep hills but should curve around their sides.

The best roads are made of a thick layer of broken stone or gravel (Fig. 236). Stone roads cost several thousand

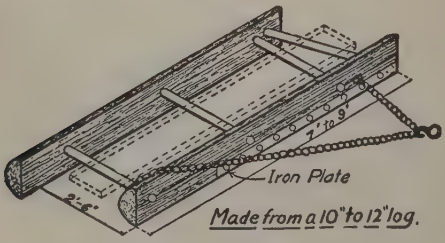



Fig. 237. — A Split-log Road Drag

dollars for each mile, and an engineer is needed to plan or build them. At slight expense earth roads can be much improved by proper grading, rounding, and draining.

**Avoid a steep rise or grade.** — A road ought to be as nearly level as possible. The grade or slope of an earth road should not be more than six feet rise in each hundred feet of length, though steeper grades are sometimes necessary. The load that one horse can pull on a level requires four

horses to haul up a grade with a rise of ten feet in each hundred feet.

**Keep the center highest.** — The center of a road should be arched so as to be at least five to ten inches above the sides. Whenever ruts or depressions remain long unfilled, mudholes or washes occur.

**A cheap road drag.** — Ruts should be filled as soon as formed. This can be done by running a split-log drag along one side of the road and back on the other side. The drag shown (Fig. 237) is made from a split log and costs very little. A little work in filling ruts as soon as they form is worth much more than the same amount after the ruts have caused washes in the road. The best way to keep earth roads good is not by having many men to work them once or twice a year, but by having a few men with teams and drags to fill the ruts as soon as they are formed. This use of the drag arches the center, fills ruts and low places, and hastens drying. There should be a ditch on each side to carry off the water and to keep the roadbed dry.

**Sand-clay roads.** — Deep sand beds make the roads bad in many parts of the South. Some counties have changed these sand beds into good firm roads by hauling clay and thoroughly mixing it with the upper six inches of sand. The clay and sand are mixed while wet by means of plows and harrows or by the wheels of vehicles. Then the road is kept constantly rounded so as to shed the water.

### Practice Work and Questions

Are sandy roads best when dry or wet? Are clay roads best when dry or wet? Watch the teams struggle up some steep hill and then consider wnether the road could easily be changed to avoid that hill or to climb it more gradually.

## CHAPTER LVIII

## MARKETING FARM PRODUCTS

Residents in the country need home conveniences, good roads, good schools, and churches. To afford these, farming must become more profitable than it has sometimes proved. One method of increasing farm profits consists in obtaining larger yields to the acre. This usually results in a lessened cost for a pound of product.

**Principles of improved marketing.** — Farmers' profits can also be increased by improvement in methods of marketing whatever is grown on the farm. Let us remember these facts:

(1) A higher price can be obtained for products that are uniform and unmixed than for those that vary in quality and appearance.

(2) The cost of marketing is less a pound for sales of large amounts of produce than of smaller quantities.

(3) The best price is paid the producer when he knows as much as the buyer about the grade of his product and about the demand for it and the prices paid elsewhere.

**A uniform product brings the best price.** — If some yellow kernels are found in shelled corn, the market price is usually reduced by several cents a bushel. If, in a carload of good hay, there are a few bales of poorer quality, the price is lowered on every ton in the car. A bale of cotton con-

taining two different grades of lint brings only the lower price of the inferior grade. A lot of fifty bales of cotton all of the same grade generally brings a higher price than fifty bales made up of various grades. Creameries have a more constant demand at higher prices for their butter than do most farmers who produce a small quantity, because creamery butter varies less from month to month.

**One breed or one variety of crop for a whole community.** — Where all the farmers of one community grow the same variety of cotton, there is no mixing of the seed or lint at the gins, and hence the growers can usually obtain the highest price. Neighborhoods that adopt one breed of cattle can secure a better price for a carload of fat cattle than is paid for equally good cattle of various breeds. Buyers of pure-bred animals are attracted to communities where there are numerous herds of the same breed, thus increasing the demand and average price. Thus neighboring farmers cease to be rivals in lowering prices when they adopt uniform production and coöperative marketing. Instead, each profits as his neighbor prospers.

**Selling in quantity.** — When a product is put on the market in a small quantity by each farmer, its sale is usually confined to a few consumers near by and to a small market that is often glutted, or overstocked. When the same uniform article is produced in such quantities as to permit car-lot shipments, it can be carried to whatever near or distant market offers the best price, for the freight a ton of products shipped in car lots is far less than if shipped in small quantities.

**Coöperative marketing.** — When only one farmer, distant from a large city, grows an acre or two of strawberries, he usually finds this crop unprofitable because of high cost of

express or freight on small shipments. Nevertheless, there are Southern communities in which each of several hundred farmers profitably grows acres of strawberries. Why do they succeed? It is because they coöperate in marketing their product. They usually form a coöperative marketing

*Courtesy of U. S. Department of Agriculture*

FIG. 238. — AN ARGUMENT FOR COÖPERATIVE MARKETING OF COTTON
The owners of these loads will compete with one another in selling and the result will be a lowering of price.

association and elect a sales manager to sell the hundreds of cars of berries grown by the members.

Coöperative marketing associations sell for farmers most of the American oranges, raisins, prunes, and nuts. In the South they are the means of selling fruits, vegetables, hogs, corn, cotton, and indeed practically every kind of farm product.

**Essential features of a farmers' coöperative marketing association.** — Among the usual features in a company organized by growers for the sale of their products are the following:

(1) The election of a sales manager who sells the products of all members;

(2) Provision for grading the product so that a uniform, high-grade, well-packed article is shipped;

(3) The *pooling*, or treating as one lot, of all articles of the same grade so that each grower receives the *average* net price obtained for the grade of products furnished by him.

**Some of the advantages of coöperative marketing.** — Among the advantages of selling farm products through coöperative organizations are the following:

(1) The greater certainty of being able to sell the product;

(2) The lower cost (to a unit of product) that results from shipment in carload lots, from the purchase in quantity of the packages, sacks, or other containers, and from other economies;

(3) The higher price usually secured resulting from the employment of a sales manager who is an expert in marketing and whose chief business is to keep posted regarding market prices;

(4) A coöperative spirit, or habit of working together by neighbors. This extends also to united efforts for improving the educational and social conditions of the community.

**Coöperative selling of hogs.** — Hogs were among the first products of Southern farms to be widely sold coöperatively. With the help of the farm demonstration agent a simple organization is formed and arrangements made for

constructing at the shipping point the necessary pens in which to unload, grade, and weigh the hogs. Regular sales days are appointed, usually one or two a month, and buyers are notified. On each sales day the hogs are graded according to weight and condition and sold to the highest bidder. If no satisfactory bid is received, the hogs are shipped in

*Courtesy of U. S. Department of Agriculture*

FIG. 239. — EGGS THAT HAVE BEEN WELL GRADED AND PACKED

carload lots to one of the large market centers. A local bank usually receives the proceeds and distributes the net receipts to the farmers according to the weight and grade of the hogs furnished by each.

**Marketing eggs.** — One of the simplest beginnings in better marketing is for the women and girls of a neighborhood to form an organization, sometimes called an "egg

circle," for selling a better grade of eggs and securing a higher price for them.

One member should be selected to sell the eggs, supervise the grading (Fig. 239), order the necessary crates, and pay out the money received. All eggs sold should be infertile, fresh, clean, and stamped with the date of laying and with the producer's mark.

**Selling one's own products.** — When a farmer must sell his own products without the help of any organization, he can often increase the price received by the following means:

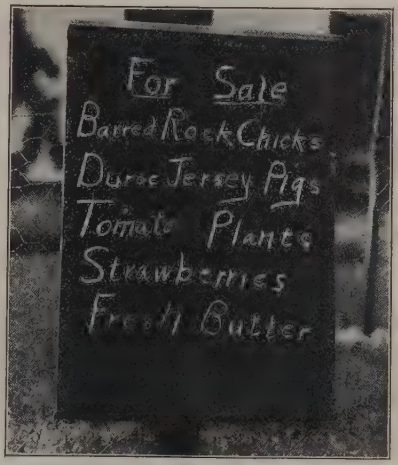



FIG. 240. — FARM BLACKBOARD FOR ADVERTISING FARM PRODUCTS

(1) Grading his product and offering for sale only the highest grades, accurately labeled;

(2) Learning what weight and kind of package his market prefers and making his bales of hay or sacks of oats or packages of other products of the exact size or weight desired;

(3) Advertising his products in newspapers and farm journals, on his letter paper, on blackboards (Fig. 240) near the road, and otherwise.

(4) Storing his products until there is demand for them at profitable prices.

**What determines price?** — The price at which an article sells is determined chiefly by its scarcity or abundance at a given time and place. That is, the price is made by the "law of supply and demand."

If the price of an article falls too low to afford a profit, the production decreases, and the resulting scarcity raises the price. When the price of a product becomes extremely high, it is less used, or more persons engage in producing it, and the resulting abundance lowers its price. Farmers can not so quickly make these changes in quantities of products as can manufacturers, because of the long time required to grow a crop or an animal.

Moreover speculation, partial monopoly, or the delay or expense of transporting an article to the place where it is most needed sometimes causes the price to rise higher or fall lower than it should. The wise farmer's aim is to avoid selling when prices are low. He is best able to sell when prices are at their highest if he is well informed, if he is not pressed by urgent debts, and if he has a suitable place for storing his products until prices become satisfactory.

### Practice Work and Questions

1. Ask your parents the prevailing prices of eggs in your neighborhood. In the market columns of a daily newspaper look up prices of eggs in one of the larger cities. Write down what you learn and report it in class to the teacher.

2. Ascertain from your parents what is the prevailing local price a pound of live hogs suitable for slaughter. Compare this with the quotations for hogs in your nearest large market center. Try to learn whether the difference is due solely to the cost of shipping, or partly to difference in quality of hogs or to other causes.

# APPENDIX

## I. Spraying and Dusting Mixtures and Insect Poisons

*For biting insects:*

(1) Powdered arsenate of lead (or calcium arsenate), 1 ounce.
Slaked or hydrated lime, 5 to 10 ounces.

*For soft-bodied sucking insects, especially plant lice:*

(2) Nicotine sulfate, 1 teaspoonful.
Water, 1 gallon.
Soap, ⅛ bar.

A homemade substitute may be prepared by boiling for an hour 1 pound of tobacco stems or dust in 2 gallons of water.

(3) Fish-oil soap (or laundry soap), 1 pound.
Water, 4 gallons.

*For scale insects and diseases of fruits, in absence of foliage:*

(4) Commercial lime-sulfur solution, 1 gallon.
Water, 8 to 9 gallons.

(5) Homemade lime-sulfur:
Flowers of sulfur, 15 pounds.
Rock lime, 20 pounds.
Water, 50 gallons.
(Salt, 15 pounds, is sometimes added.)

Mix the sulfur with a very small amount of water, slake the lime in 5 to 10 gallons of hot water; add the sulfur; dilute to 25 gallons; boil for 45 minutes; then

dilute with hot water to make 50 gallons; strain the mixture and promptly spray it on the twigs and trunks of trees.

*For cotton-boll weevil:*

(6) Calcium arsenate, applied as a dust by special machines.

*For Mexican bean beetle:*

(7) Tricalcium arsenate, 1 pound.
Flowers of sulfur, 1 pound.
Slaked or hydrated lime, 4 pounds.

Apply this mixture through a dusting machine in such a way as to reach the under sides of the leaves of beans or other plants. For other poisons to use against the Mexican bean beetle, consult the Experiment Station of your state.

*For cutworms, grasshoppers, and the like:*

(8) Powdered arsenate of lead (or calcium arsenate), ¼ pound.
Wheat bran, 4 pounds.
Sirup, 1 cup.

Moisten the mixture with water containing the juice of one lemon. About sunset drop small amounts of this poisoned bait near the plants to be protected. Keep poultry away.

*For insects in corn, beans, and the like, stored in tight cribs or bins:*

(9) Carbon disulfid ("highlife").

Use about two teaspoonfuls of carbon disulfid to each cubic foot of space; pour the liquid into an open shallow can placed on top of the grain; cover the grain with cloth. The liquid evaporates and the heavy fumes settle downward. The fumes are very inflammable; hence, keep all lights and all smokers away until the odor has disappeared.

*For fungous diseases of apples, pears, and vegetables:*

(10) Bordeaux mixture:

Bluestone (copper sulfate), 4 to 5 pounds.
Rock lime, 5 pounds.
Water, 50 gallons.

Slake the lime to a creamy condition by the use of a little water, and then dilute to 25 gallons; in a wooden vessel dissolve the bluestone in 25 gallons of water; do this by placing the bluestone in a bag and suspending it just below the surface of the water; into a third vessel gradually pour the two liquids, letting them mix as they are poured; strain thoroughly; make a fresh mixture every time, or consult your Experiment Station about making a concentrated preparation that will keep.

One to 2 pounds of powdered arsenate of lead may be added to 50 gallons of Bordeaux mixture, thus destroying both biting insects and fungi at the same time.

(11) Self-boiled lime-sulfur:

Rock lime, 8 pounds.
Flowers of sulfur, 8 pounds.
Water, 50 gallons.

Slowly slake the lime in a little hot water, at the same time gradually adding the sifted sulfur; stir continuously; as soon as the lime is completely slaked, that is, in about five to ten minutes, dilute with cold water to make 50 gallons; strain out the coarse particles of lime.

To poison the curculios, which cause wormy peaches, add 1 pound of powdered arsenate of lead to the self-boiled lime-sulfur that is being used against the brown rot of fruit.

*For smut in oats and for disinfection of Irish and sweet potatoes:*

(12) Formalin (formaldehyde):

For wheat or oats, pour one ounce of formalin into three gallons of water. Dip or thoroughly moisten the

seed grain, and leave it moist and covered for six hours. Then dry the grain, and sow it before it comes in contact with more smut germs.

To prevent scab, soak the seed potatoes for two hours in a solution of 1 ounce of formalin in 2 gallons of water.

For destroying disease germs on sweet and Irish potatoes there is sometimes substituted for formalin a solution of corrosive sublimate, usually 1 part to 1000 parts of water. A weaker solution is sometimes employed for destroying germs of certain diseases on seeds of watermelons, tomatoes, and the like.

## II. Average Digestible Matter in 100 Pounds of Feeding Stuffs

| Feeding Stuffs | Dry Matter in 100 Pounds | Digestible nutrients in 100 lbs. | | | | Nutritive Ratio |
|---|---|---|---|---|---|---|
| | | Crude Protein | Carbohydrates | Fat | Totals | |
| Corn or corn meal | 89.5 | 7.5 | 67.8 | 4.6 | 80.7 | 10.4 |
| Oats | 90.8 | 9.7 | 52.1 | 3.8 | 70.4 | 6.3 |
| Cowpeas (seed) | 88.4 | 19.4 | 54.5 | 1.1 | 76.4 | 2.9 |
| Soy beans (seed) | 90.1 | 30.7 | 22.8 | 14.4 | 85.9 | 1.8 |
| Velvet beans (seed) | 88.3 | 18.1 | 50.8 | 5.3 | 80.8 | 3.5 |
| Velvet beans (seed and pod) | 87.7 | 14.9 | 51.7 | 3.8 | 75.2 | 4.0 |
| Cotton seed | 90.6 | 13.3 | 29.6 | 16.5 | 80.0 | 5.0 |
| Cottonseed meal (prime) | 92.2 | 33.4 | 24.3 | 7.9 | 75.5 | 1.3 |
| Peanut meal (no hulls) | 89.3 | 42.8 | 20.4 | 7.2 | 79.4 | .9 |
| Soy-bean meal | 88.2 | 38.1 | 33.9 | 5.0 | 83.2 | 1.2 |
| Wheat bran | 89.9 | 12.5 | 41.6 | 3.0 | 60.9 | 3.9 |
| Wheat shorts | 89.5 | 13.4 | 46.2 | 4.3 | 69.3 | 4.2 |
| Rice (rough) | 90.4 | 4.7 | 64.6 | 1.7 | 73.1 | 14.6 |
| Rice bran | 89.9 | 7.9 | 38.1 | 8.8 | 65.8 | 7.3 |
| Rice polish | 90.0 | 8.0 | 57.2 | 7.5 | 82.1 | 9.3 |
| Tankage (55–60 per cent protein) | 92.5 | 54.0 | ..... | 12.7 | 82.6 | .5 |
| Molasses (blackstrap) | 74.2 | 1.0 | 58.2 | ..... | 59.2 | 58.2 |
| Sweet potatoes | 31.2 | .9 | 24.2 | .3 | 25.8 | 27.7 |
| Cow's milk | 13.6 | 3.3 | 4.9 | 4.3 | 17.9 | 4.4 |
| Skimmed milk | 9.9 | 3.6 | 5.1 | .2 | 9.1 | 1.5 |
| Alfalfa hay | 91.4 | 10.6 | 39.0 | .9 | 51.6 | 3.9 |
| Red-clover hay | 87.1 | 7.6 | 39.3 | 1.8 | 50.9 | 5.7 |
| Crimson-clover hay | 89.4 | 9.7 | 36.8 | 1.0 | 48.7 | 4.0 |
| Cowpea hay | 90.3 | 13.1 | 33.7 | 1.0 | 49.0 | 2.7 |
| Lespedeza hay | 88.2 | 8.6 | 41.1 | 1.1 | 52.2 | 5.1 |
| Peanut hay | 78.5 | 6.6 | 37.0 | 3.0 | 50.4 | 6.6 |
| Soy-bean hay | 91.4 | 11.7 | 39.2 | 1.2 | 53.6 | 3.6 |
| Velvet-bean hay | 92.8 | 12.0 | 40.3 | 1.4 | 55.5 | 3.6 |
| Beggarweed hay | 90.9 | 11.6 | 36.2 | .7 | 49.4 | 3.3 |
| Timothy hay | 88.4 | 3.0 | 42.8 | 1.2 | 48.5 | 15.2 |
| Johnson-grass hay | 89.9 | 2.9 | 45.0 | 1.0 | 50.1 | 16.3 |
| Sudan hay | 90.0 | 2.7 | 45.4 | .7 | 49.7 | 17.4 |
| Oat hay | 88.0 | 4.5 | 38.1 | 1.7 | 46.4 | 9.3 |
| Crab-grass hay | 90.5 | 3.5 | 40.0 | 1.0 | 45.7 | 12.1 |
| Corn silage | 26.3 | 1.1 | 15.0 | .7 | 17.7 | 15.1 |
| Sorghum silage | 22.8 | .6 | 11.6 | .5 | 13.3 | 21.2 |

## III. Digestible Nutrients Required Each Day by Farm Animals*

| Animal | Digestible Crude Protein Lb. | Total Digestible Nutrients Lb. | Nutritive Ratio |
|---|---|---|---|
| Dairy cows, weighing about 800 pounds: | | | |
| For mere maintenance, etc. | 1.06 | 6.34 | 1:6 |
| When giving 2 gallons of rich milk | 2.30 | 13.3 | 1:5.7 |
| When giving 3 gallons of rich milk | 2.90 | 16.7 | 1:5.7 |
| When giving 4 gallons of rich milk | 3.60 | 20.2 | 1:5.6 |
| Growing calves, weighing about 200 pounds | .68 | 3.5 | 1:4.1 |
| Pigs, weighing 50 to 100 pounds (for each 1,000 pounds) | 5.5–6.0 | 32.9–36.4 | 1:5–5.6 |
| Pigs, weighing 100 to 150 pounds (for each 1,000 pounds) | 4.4–4.9 | 28.6–31.9 | 1:5–6.2 |
| Horses or mules (1,000 pounds) at medium work | 1.4–1.7 | 12.8–15.6 | 1:7–8.3 |
| Hens laying freely, egg breeds (per 100 pounds of weight) | 1.0 | 5.54 | 1:4.5 |

*Adapted from Henry & Morrison's "Feeds and Feeding." For dairy cows half a pound additional of digestible protein a day has been substituted for an equal weight of digestible carbohydrates because of relative cheapness of protein in the Southern States.

## IV. Agricultural Experiment Stations and Extension Services of the Southern States

Alabama—*Auburn.*
Arizona—*Tucson.*
Arkansas—*Fayetteville.*
California—*Berkeley.*
Florida—*Gainesville.*
Georgia—*Experiment* and *Athens.*
Kentucky—*Lexington.*
Louisiana—*Baton Rouge.*
Mississippi—*Agricultural College.*
New Mexico—*State College.*
North Carolina—*Raleigh.*
Oklahoma—*Stillwater.*
South Carolina—*Clemson College.*
Tennessee—*Knoxville.*
Texas—*College Station.*
Virginia—*Blacksburg.*

# INDEX


Abelia, Chinese, 193, 195
Aberdeen-Angus cattle, 290
Acid phosphate, 91
  soil, 98
Agriculture, defined, 3
Air, plant food from, 24-27
Alfalfa, 163
Alkaline soil, 98
Ammonia, 87
Ammoniated fertilizer, 88
Ancona chickens, 300
Annuals, 33
Anther, 30,35
Apple, flower, 31
  scab, 225
  worm, 260
Argentine ant, 261
Ash in feeds, 313
Association for marketing, 353
Available plant food, 53

Babcock milk tester, 329
Bacteria, 156, 227
Balanced ration, 316
Barley, 119-125
Barnyard manure, 84-86
Basic phosphate, 91
Bean beetle, Mexican, 257
Bean, family, 32
  soy, 158
  velvet, 159
Beef cattle, 289-292
Beekeeping, 272-277
Beggarweed, 160
Begonia, 198
Berkshire hog, 299
Bermuda grass, 171
Biennials, 33
Biting insects, 252-253
Bitter rot of apples, 226
Black Polled cattle, 290
Black root, 234
  rot, 231
  rust, 238
Blue Stem wheat, 122
Bluestone, 219
Bordeaux mixture, 220
Bracts, 31
Brahma chickens, 302
Breeding, live stock, 278-288
  plants, 43-49
Bridal wreath, 193
Brooders, 309
Brown rot of peaches, 224
Budding, 202-203
Buds, propagation by, 180
Buildings, farm, 346
Bulbs, 196
Bur clover, 164
Burt oats, 112
Butter making, 334-338

Cactus, crab, 198
Calcium, 20
Calf, feeding of, 324-328
Canals, 71

Cankers, 226
Canna, 196
Capillary moisture, 57
Carbohydrates, 314
Carbon dioxide, 26
  disulfid, 256
Carbonic acid, 53
Carnation, 197
Caterpillars, 242
Cattle, 289-295
Chalk, 98
Chickens, 300-311
Chlorophyll, 26
Chrysalis, 242
Chrysanthemum, 196
Churning, 336
Cion, 200
Clay, 52, 54
Cleveland cotton, 129
Clover, bur, 164
  crimson, 162
  Japan, 160
  red, 163
  white, 163
Clydesdale horse, 282
Cochin chickens, 302
Cocoon, 243
Codling moth, 260
Coldframe, 189
Commercial fertilizers, 87-93
Complete fertilizer, 92
Composts, 86
Concentrated feeds, 326
Contact insecticides, 256
Cook Improved cotton, 129
Coöperative marketing, 351-356
Copper sulfate, 219
Corn, 103-109
  insect enemies of, 263-265
Corn, machinery for, 344
  seed, 111-118
Cornflower, 197
Corolla, 30
Cosmos, 198
Cotton, 126-133
  diseases of, 233-239
  flower, 31
  insect enemies of, 263-265
  machinery for, 345
Cotton-boll, rot, 237
  weevil, 266-271
  worm, 265
Cotton-leaf worm, 265
Cotton-root rot, 238
Cottonseed meal, 88
Cow, feeding of, 324-328
Cowpea, 158
Cream, 334
Crop rotation, 165-169
Crossing plants, 47
Cross-pollination, 36, 48
Cultivation of soil, 61-64
Curculio, 261
Cuttings, propagation by, 181

Dahlia, 196
Dairy cattle, 292-295
Dairying, 329-338
Decay of vegetable matter, 53
Dent corn, 105
Diseases, of cotton, 233-239
  of fruits, 223-227
  of grains, 218-222
  of potatoes, 228-232
  of tomatoes, 228-232
Ditches, open, 71
Division, propagation by, 180-184
Dogwood, 194

Dorset sheep, 286
Drainage, 58, 66-72
Duroc-Jersey hog, 299

Eggs, 310-311
  marketing of, 354
Elder, 194
Electric lights, 7
Elm, 216
Exhausting the soil, 75

Families of plants, 32
Fanning machines, 16
Farm animals, food for, 312-316
Farm buildings, 346
Farm implements and machinery, 339-346
Farm products, marketing of, 350-356
Fattening, 315
Fat in feeds, 315
Feeds, composition of, 312
  for cows, 324-328
  for hogs, 317-323
Fertilization, 35
Fertilizers, amount and kinds to use, 94-97
  commercial, 87-93
Feterita, 173
Field corn, 105
Fire, blight, 226
  forest, 216
Flies, 245
Floats, 91
Florida phosphate, 91
Flower, parts of, 29-33
Flower game, 199
Flowers, growing of, 193-199
Food from soil, 18,52
Forage, legumes for, 158-164
Forests, 214-216
Formalin, 219
Four-o'clocks, 198
Foxglove, 196
Free water, 57
Fruit, 35
Fruit crop, failure of, 39
Fruit diseases, 223-227
Fruit trees, growing of, 204-207
Fulcaster wheat, 122
Fulghum oats, 112
Fultz wheat, 122
Fungi, 218

Gaillardia, 197
Galloway cattle, 291
Gardens, window, 198
Geranium, 198
Germination of seeds, 8-13
Germination test, 14
Germ of seed, 8
Germs, 153
Grafting, 200-202
Grain, machinery for, 340
Grain diseases, 218-222
Grains, small, 119-125
Granulation, 54
Granule, 54
Grasses for pasture, 170-173
Grass family, 32
Grass worm, 263
Gravel, 55
Ground limestone, 98
Grubs, 242
Guano, 88
Guernsey cattle, 294
Gum, black, 217
  sweet, 216

Hackberry, 217
Hampshire hog, 299
  sheep, 286, 287
Haymaking machinery, 341-344
Health and insects, 245-251
Hereford cattle, 290
Hogs, 295-299
  diseases of, 322
  feeding of, 317-324
  marketing of, 353
Holly, 194
Hollyhock, 196, 198
Holstein-Friesian cattle, 295
Honey, 274
Horses, 281-285
Hotbed, 189
Humus, 52
Hydrangea, 194

Implements, farm, 339-346
Improvement of plants, 43-49
Incubators, 309
Inoculation of leguminous plants, 152-157
Insecticides, contact, 256
Insects, 240-265
  as pollenizers, 37

Japan clover, 160
Jersey cattle, 293
Jonquils, 196

Kafir, 173
Kainite, 91
Kerosene emulsion, 256
Kudzu, 160

Langshan chickens, 302
Larkspur, 196, 198
Leaching, 73
Leaf structure, 25
Leghorn chickens, 300
Legumes, for forage and soil improvement, 158-164
  inoculation of 152-157
  to enrich soil, 77-83
Lespedeza, 160
Light for manufacture of plant food, 26
Lime, 20, 52, 98-101
Limestone, ground, 98
Lime-sulfur wash, 261
Live stock, improvement of, 278-288
Loam, 55
Lone Star cotton, 130

Machinery, farm, 339-346
Maggots, 242
Mail delivery, 7
Malaria, 245
Manure, barnyard, 84-86
Maple, 217
Marigold, 198
Marketing farm products, 350-356
Merino sheep, 287
Mexican bean beetle, 257
Mexican cotton-boll weevil, 266-271
Milk, production of, 329-333
Milo, 173
Minorca chickens, 300
Mixed fertilizers, 92
Moisture from soil, 18, 57-59
Molds, 218
Mosquitoes, 246
Mulberry, 216
Mulch, 59
Mules, 285
Multiplying plants, 180-184
Muriate of potash, 91

Mustard flower, 29
Myrtle, pink crape, 193

Narcissus, 196
Nightshade family, 32
Nitrate of soda, 89
Nitrogen, 20, 52, 87
Nitrogenous fertilizers, 87
Nodules on roots, 80
Nutritive ratio, 316

Oak, 216
Oats, 119-125
Oat smut, 221
Oil in feeds, 315
Open ditches, 71
Organic matter in soil, 52
Orpington chickens, 301
Ovary, 29
Ovule case, 29
Ovules, 29, 35
Oxygen, 53

Pansy, 197
Pastures, making of, 170-173
Peach, borer, 258
  flower, 31
  leaf curl, 225
Peanut meal, 319
Peanuts, 145-147
Percheron horse, 282
Perennials, 33
Perfect flowers, 40
Perfect varieties, 39
Petals, 30
Petunia, 198
Phlox, 197
Phosphates, kinds of, 90
Phosphoric acid, 52
Phosphorus, 20
Pigs, 295-299
  feeding of, 317-324
Pink, 197
Pistil, 29, 35
Pistillate flowers, 40
Plant, breeding, 43-49
  families, 32
  food from air, 24-27
  food from soil, 18, 52
Plowing, 61
Plymouth Rock chickens, 301
Poland-China hog, 299
Polled Angus cattle, 290
Pollen, 29, 30, 35
Pollination, 34-41
Pomegranate, 194
Poppy, 196
Potash, 20, 52
  in fertilizers, 91
Potassium, 20
Potato, diseases of, 228-232
Potato, sweet, 141-144
Potato beetle, 256
Poultry, 300-311
Preparation of soil, 61-64
Price, determination of, 356
Privet, Amoor River, 193
Propagation of plants, 180-184
Protein, 313
Protoplasm, 26
Pruning, 207-211

Quicklime, 98

Rag-doll seed tester, 17
Ragged robin, 197
Rakes, horse, 341
  sweep, 343
Ration, balanced, 316

Redbud, 194
Red Polled cattle, 291
Resting land, 77
Rhode Island Red chickens, 301
Rice, machinery for, 344
Rice polish, 319
Roads, earth, 347-349
Root hairs, 20
Root knot, 233
Rose family, 32
Roses, 194-195
Rotation of crops, 165-169
Rotting of vegetable matter, 53
Runners, propagation by, 182
Rural life, 6
Rye, 119-125

Sage, scarlet, 198
Sand, 52, 54
San José scale, 261
Sap, 20
Sapwood, 22
Sea-island cotton, 128
Seed, bed, 61
  case, 35
  coat, 9
  corn, selecting or judging, 111-118
  germination, 8-13
  testing, 8, 14-17
Selection, 43
Self-binder, 340
Self-pollination, 36, 48
Sepals, 30
Separator, cream, 334
Shade trees, 212-217
Shading, 27
Sheep, 285-287
Shetland ponies, 284
Shorthorn cattle, 291
Shorts, 319
Shredders, 344
Shropshire sheep, 286, 287
Shrubs, 193-194
Silage, 327
Sirup making, 139
Slaked lime, 98
Small grains, 119-125
Smut, of oats, 221
  of wheat, 222
Snowball, 193
Sodium fluorid, 310
Soil, acid, 98
  alkaline, 98
  cultivation of, 61-64
  deterioration of, 73-76
  how formed, 50-55
  improvement, legumes for, 158-164
  kinds of, 54
  toxins, 93
  water and food from, 18, 53, 57
Sorghum, 172
Sour soil, 98
Southdown sheep, 286, 287
Soy bean, 158
Stamens, 30
Staminate flowers, 40
Starch in seed, 8, 9
Starter for butter, 336
Stigma, 29
Stock, 201
Stomata, 26
Strawberries, failure to bear, 38
  propagation of, 182
Subsoil, 51
Subsoil plowing, 64
Subsoiling, 64
Suckers, 134

Sucking insects, 253
Sudan grass, 172
Sugar cane, 134-140
  machinery for, 344
Swarming of bees, 273
Sweet peas, 196
Sweet potatoes, 141-144
Sweet William, 197
Swine, 295-299
  feeding of, 317-324

Tankage, 319
Tedders, 341
Telephones, 7
Tennessee phosphate, 91
Terracing, 66-69
Testing seed, 8, 14-17
Tick fever, 248
Ticks, 248
Tile drains, 71
Timber trees, 212-217
Tomato, diseases of, 228-232
  flower, 31
  growing, 190
Toole cotton, 130
Toxins, soil, 93
Tractors, 340
Trees, fruit, 204-211
  shade and timber, 212-217
Triumph cotton, 130
Triumph sweet potato, 143
Tubercles on roots, 80
Tubers 196
Tulip, 196
Turf oats, 122
Typhoid fever, 245

Unavailable plant food, 53
Underdrains, 70, 71

Vegetable growing, 185-192
Vegetable matter in soil, 52
Velvet bean, 159
Verbena, 197
Vetches, 161
Violet, 196
Vitamines, 324

Washing of soil, 73
Water from soil, 18, 57
Watermelons, 147-150
Waterworks, 7
Weeds, 174-179
Weevils, 264, 266-270
Wheat, 119-125
  smut, 222
Wilt diseases, 231
  of cotton, 234
Window gardens, 198
Wistaria, 193
Wyandotte chickens, 301

Yellow fever, 245

Zinnia, 198

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